

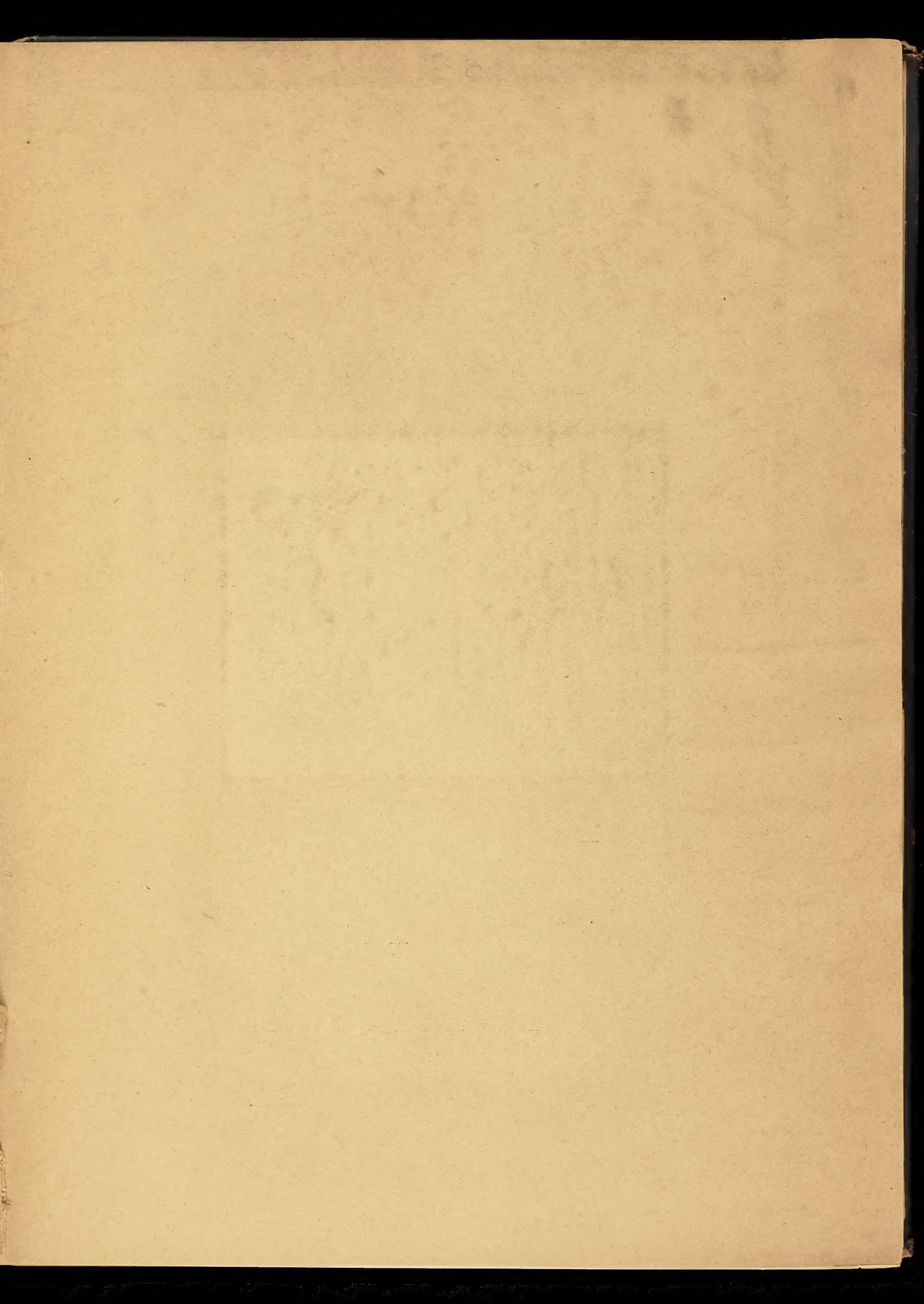
ROLL-TURNING
FOR
SECTIONS IN STEEL AND IRON

APPENDIX

ADAM SPENCER



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ROLL-TURNING,

FOR

SECTIONS IN STEEL AND IRON:

BY

ADAM SPENCER,

West Hartlepool.

(ROLLING MILLS MANAGER; INVENTOR OF SPENCER'S REVOLVING PUDDLING MACHINE, ETC.)

ROLL-TURNING

FOR

SECTIONS IN STEEL AND IRON

WORKING DRAWINGS FOR RAILS, SLEEPERS, GIRDERS,
BULBS, TIES, ANGLES, &c. &c.

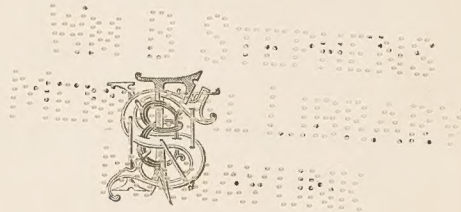
ALSO BLOOMING AND COGGING, FOR PLATES AND BILLETS

Second Edition

WITH AN APPENDIX CONTAINING 22 ADDITIONAL FOLDING PLATES

BY

ADAM SPENCER



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1894

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LIST OF PLATES.

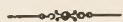


PLATE NO.

- I.—BLOOM ROLL (ONE OF PAIR) FOR PLATE SLABS. Top roll arranged to lift 30 inches.
- II.—COGGING AND BILLET ROLLS. Top roll balanced; necks as in Plate I.
- III.—BLOOMING FOR 7" × 7" BLOOMS. Pass twice through each hole.
- IV.—ROUGHING FOR STEEL FLANGE RAILS. Full size.
- V.— " " "
- VI.— " " "
- VII.— " " "
- VIII.— " " "
- IX.—ROUGHING 35 TO 50 LBS. FLANGE RAILS. Scale 3" = 1 foot, 21" train.
- X.—ROUGHING 30 TO 40 LBS. AND 40 TO 60 LBS. FLANGE RAILS. Scale 3" = 1 foot, 31½" train.
- XI.—FINISHING STEEL FLANGE RAILS. Scale 3" = 1 foot, 30" train.
- XII.— " " Full size.
- XIII.— " " "
- XIV.— " " "
- XV.— " " Scale 3" = 1 foot, 24" train.
- XVI.—FINISHING BRIDGE RAILS. Scale 3" = 1 foot, 28" train.
- XVII.—ROUGHING FOR RAILWAY SLEEPERS (STEEL). Scale 3" = 1 foot, 28" train.

PLATE NO.

- XVIII.—FINISHING FOR RAILWAY SLEEPERS (STEEL). Scale $3'' = 1$ foot, $28''$ train.
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- XXX.—ROUGHING FOR BULB ANGLES. Scale $3'' = 1$ foot, showing collars. Also TAPER GAUGE FOR COLLARS. Full size.
- XXXI.—FINISHING FOR BULB ANGLES, $7\frac{1}{2}'' \times 3''$. Scale $3'' = 1$ foot, showing collars, $22''$ train.
- XXXII.—FINISHING FOR BULB ANGLES, $6\frac{1}{2}'' \times 3''$. Scale $3'' = 1$ foot, showing collars, $22''$ train.
- XXXIII.—FINISHING FOR BULB ANGLES, $6\frac{1}{2}'' \times 3''$. Full size diagrams only.
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PLATE NO.

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XXXVIII.— " $6'' \times 4''$ " " "

XXXIX.— " $5\frac{1}{2}'' \times 3\frac{1}{2}''$ " " "

XL.— " $5'' \times 4''$ " " "

XLI.— " $5\frac{1}{2}'' \times 3''$ " " "

XLII.— " $5\frac{1}{2}'' \times 4''$ " " "

XLIII.— " $5'' \times 3''$ " " "

XLIV.— " $5'' \times 3''$ " " $28''$ train.

XLV.— " $4'' \times 3\frac{1}{2}''$ " " $22''$ train.

XLVI.— " $5'' \times 4''$ Full size diagrams only.

XLVII.— " $6'' \times 3''$ " " (3) "

XLVIII.— " $5'' \times 3''$ " " "

XLIX.—Do. FOR TEES, $5'' \times 2\frac{1}{2}''$ " " (5) "

L.— " $4'' \times 4\frac{1}{2}''$ " " (5) "

LI.— " $6'' \times 3''$ " " (6) "

LII.— " $6'' \times 4''$ " " (6) "

LIII.—FINISHING TRAM RAILS. Full size diagrams only. Also HOT AND COLD BRIDGE FINISHING.

LIV.—FINISHING 56 LBS. TRAM RAILS. Full size diagrams (5) only.

LV.—FINISHING 14 LBS. BRIDGE RAILS, 22 LBS. FLANGE RAILS, AND $2\frac{1}{2}'' \times 2''$ ANGLES. Full size diagrams only.

LVI.—FINISHING PERMANENT-WAY BRIDGE RAILS. Full size diagrams only.

ROLL-TURNING

FOR

STEEL BARS AND PLATES.



THE subject of roll-turning has been treated in the accompanying work from a purely practical point, and for practical men; no attempt has been made to theorise or deduce principles. The drawings are the result of experience, and were at first intended for my private use and guidance. Their value consists in the fact that they are working drawings—that is, drawings of rolls which have passed through the ordeal of actual work. But every roll-turner will know that many conditions affect the successful working of rolls—viz., the size of the train, speed of rolls, temperature of the material rolled, and the manual or mechanical manipulation of the bloom to that of the finished section. Besides, the setting of the rolls by the roller is of vital importance; and, unless these conditions meet in their proper relation, much material is wasted, and sometimes the roll-turner blamed.

In reference to the drawings themselves, every care has been taken to give the exact form in each groove and the position of the collars, but the practical roll-turner will at once see that the taper of the collars where the top roll fits into the bottom, the rounding of the edge of collars, space between top and bottom rolls, have in many cases not been attended to. The amount of taper required in collars to provide for sinking and dressing, and thus take up the slack occasioned by wear, is a matter of opinion. I have, however, with

Plate XXX., given a full-size sketch of a taper gauge. These are points of importance upon which a roll-turner will use his own taste and judgment.

The arrangement of the work :—I give, in the first place, drawing of modern blooming for steel slabs, followed by pair of billet rolls, and then proceed to various sections, showing the related grooves in cogging, roughing, and finishing rolls, with the position and character of collars required. For every class of sections a complete set of rolls is in substance given. To have drawn collars and grooves for a tenth part of the number of sizes of each class would, I feared, have made the work bulky and too expensive. I therefore add several plates of drawings of full-size templates of various sections and sizes. On Plates XLIII. and XLIV. I give angles of the same size, but the size of train and arrangement of grooves and collars are widely different. In most cases of angles the flanges are rolled up, but in Plate XLV. this is reversed. Many mill-managers consider this an improvement, as the roll scale falls off better, and a cleaner bar is the result.

As the drawings are full size, or one-quarter size, detailed explanations would be tedious and unnecessary. In conclusion, I may remark that demands upon the skill of the roll-turner are daily increasing. Engineers are continually requiring new forms and combinations of old forms, thus giving to the roll-turner a position of importance second to none in the rolling mill. The art can never be stereotyped, but I trust that this small contribution will be of use to all interested in the manipulation and application of steel bars.

Mr. Jenkins, General Manager of the celebrated Steel and Iron Works at Consett, Durham, having seen my work in manuscript, has kindly given his opinion in the following letter, which I now have the gratification, with his permission, of publishing, and hope for the success so kindly expressed.

ADAM SPENCER.

WEST HARTLEPOOL,
8th August, 1891.

CONSETT IRON WORKS,
BLACKHILL, CO. DURHAM.

DEAR SIR,

I have much pleasure in stating that I have known you and your father, and many other members of your family, in the North of England, Staffordshire, and in South Wales, during the last forty or fifty years.

As you and so many of the members of your family have been for a couple of generations so closely associated with roll-turning and rolling mills, I have no hesitation in saying that I believe the work, which I have examined, and which you propose to publish, on the subject of rolling sectional iron and steel, i.e., rails, angles, T-iron, bulb iron, &c., would be very interesting and instructive to all those connected with the practical work of producing iron and steel in the above-named forms.

The experience you have had personally, will, I believe, well qualify you for the work you intend to publish, and which will exhibit very numerous sections by diagrams, in full size and otherwise, of the grooves best adapted for successful work in the rolling mill.

When complete I shall be glad to take, say, half-a-dozen copies of your work, for distribution here at these works to some of our practical men.

Wishing you success in your undertaking,

I am, yours faithfully,

W. JENKINS,

General Manager, Consett Iron Co., Limited.

ADAM SPENCER, ESQ.

ROLL-TURNING.



APPENDIX.

My main object in this, has been to illustrate roll-turning as applied to merchant-bars. Taking rounds as representative, I begin with guide mills, and show roughing and finishing down to $\frac{3}{16}$ " diameter; and increasing the size of mill gradually, rolls are shown for rolling rounds as large as $8\frac{1}{2}$ " diameter. In addition to the merchant-bar rolls, a few examples of sections such as are rolled in the larger mills have been introduced.

The drawings for the most part have been made from full-size working templates, and in some cases from the tools themselves. In all cases they are of rolls long in use, and of approved construction; and although the grooves may not in form and draught accord precisely with the method of construction which I give on Plate LXXVIII., they may be considered thoroughly practical and reliable.

A glance at the list of plates, with their titles, will give a fair idea of the ground I have endeavoured to cover: three-high roughing rolls, with grooves for finishing in two-high rolls, are given for 8" (two illustrations), 10", 12", and 14" mills; and in all cases, except the first grooves (flat and edge), for the 14" mill the drawings are full size. For the 16" and 18" roughing rolls a scale of 3" to the foot has been adopted, but where rolls for the finished bar has been illustrated the grooves are given full size, and so on till we come to Plates LXXIII. and LXXIV., where Gothic roughing in a 34" train, for large rounds, is shown; the grooves in this case also (except the flat and edge) are full size.

I may explain that Plates LVII. and LVIII., 8" Guide mill rolls, are according to Welsh practice. Plates LIX. and LX., 10" Guide mill rolls, are

according to north of England practice; so also are the rolls shown on Plates LXI. and LXII. for 12" Bar mill.

Plates LXIII. and LXIV., for 14" Bar (and Guide) mill, with three-high roughing, represents a mill in the Cleveland district, where guide iron, medium sized merchant-bars, small rails, fish plates, and light sections are rolled in large quantities, and is an arrangement introduced by a most excellent and experienced roll-turner.

In reference to Plate LXXVIII.: "Method of drawing grooves for squares, diamonds, Gothics, rounds, and ovals" for guides; it will be seen that I have used an angle of 92° for squares, and 95.5° for diamonds and Gothics. Both may be considered by some roll-turners as scarcely obtuse enough, but as so much depends upon the character and temperature of the iron or steel rolled, any modification of the angle will be based upon these circumstances and upon individual experience. I am aware that some roll-turners use an angle of 92.5° for squares, and 100° for diamonds and Gothics. I prefer the angles as represented, with the draughts as shown, and a liberal and proportionate amount of tailoring to prevent any possibility of pinching or "finning." I may also remark that the rule given for drawing rounds and ovals is not that adopted by all roll-turners; for rounds of small and medium size it may be considered too close, and for large rounds too open. I would, however, point out that it has the merit of simplicity, and may be modified for different size rounds by altering the tailoring curves only. But I do not recommend any such alteration unless practice and special experience of the roller require a modification. As to the ovals for guide mill rolls, the rule given accords with drawing on Plate LX., the curve being drawn from one radius. But on Plate LVII. the curves for ovals are from two different radii, more like the ellipse formed by cutting a cylinder diagonally. This, in the opinion of some roll-turners, is most suitable for the smaller rounds.

"Guard" to prevent "fins."—This is well illustrated on Plate LXXV.,

Tees ; and consists in rounding or flattening the corners in the bottom groove at the point where the part comes in the succeeding groove between the collars.

"Tailoring" to prevent "fins" being formed on the material rolled, and abrasion of the rolls.—This is a rounding of the collars of top and bottom rolls at the point where the grooves in both rolls meet, and is applicable to parting grooves, such as are shown for rounds, squares, and Gothics, also grooves of the "open" kind—that is, where the collar of the bottom roll is not sunk into that of the top roll.

"Spread."—This is an allowance in width of groove, so that the piece or bar may enter each succeeding groove easily.

"Contraction."—As the bar when red hot is larger in size than when cold, the groove must be made larger by this difference ; this allowance for contraction varies with the temperature at which the bar is finished. On Plate LXXVII. it is about 1 in 77 ; this is found by comparing the size of the finishing groove with the section of rail shown alongside. From templates which I have of a similar sized rail, by comparing the "hot" and "cold" templates the allowance for contraction is about 1 in 42.

"Spring."—This is an allowance for the bending of the rolls when the bar passes between, and depends much upon the position of the groove and amount of draught, also upon the length and size of rolls, and the malleability of the material operated upon. This allowance for "spring" must be deducted from the allowance for contraction, in the vertical direction only.

"Space" between collars of top and bottom rolls.—In most of the drawings I have shown the collars touching ; this is not the case in practice, and in turning the grooves an allowance must be made for the rolls to run clear of each other. This also must be taken off the allowance for contraction in a vertical direction. Say a 3" diameter round bar is required—the groove in each roll is not quite $1\frac{1}{2}$ " deep—the space between the rolls and the "spring" must be considered, and due allowance made.

"Templates."—First a drawing, then the "male" template, then a "female" template, and into this latter the tool for turning the groove should be accurately fitted.

These points are of importance in the art of roll-turning, and I mention them only that beginners may value their craft, take a pride and pleasure in their work, and learn it thoroughly.

ADAM SPENCER.

July 13, 1893.

LIST OF PLATES

TO

APPENDIX.



PLATE NO.

LVII.— { FIRST ROUGHING, THREE-HIGH, FOR 8" GUIDE MILL GROOVES.
Full size.
FINISHING FOR 8" GUIDE MILL ROUNDS AND OVALS TO CORRESPOND.

LVIII.—THREE-HIGH ROUGHING FOR 8" GUIDE MILL (2ND ILLUSTRATION)
GROOVES. Full size.

LIX.—FIRST ROUGHING FOR 10" GUIDE MILL, THREE-HIGH GROOVES. Full
size.

LX.— { FIRST ROUGHING FOR 10" GUIDE MILL, THREE-HIGH GROOVES. Full
size.
FINISHING FOR 10" GUIDE MILL, OVALS, AND ROUNDS, $1\frac{1}{16}$ " TO $\frac{1}{4}$ ".

LXI.—THREE-HIGH ROUGHING FOR 12" BAR MILL GROOVES. Full size.

LXII.— { THREE-HIGH ROUGHING FOR 12" BAR MILL GROOVES. Completing
Pl. LXI. Full size.
ALSO FINISHING FOR 12" BAR MILL ROUND $1\frac{9}{16}$ " TO $\frac{5}{8}$ ".

PLATE NO.

- LXIII.—THREE-HIGH ROUGHING FOR 14" BAR (AND GUIDE) MILL. Scale $3\frac{1}{2}" = 1$ foot.
- LXIV.—GOTHIC AND DIAMOND GROOVES. Full size for 14" Bar Mill, see Plate LXIII.
- LXV.—ROUGHING FOR 16" MILL. Scale $3" = 1$ foot.
- LXVI.—ROUGHING FOR 18" MILL. Scale $3" = 1$ foot.
- LXVII.—SASH BARS (5 sets). Full size.
- LXVIII.—SADDLES (2 sets). Full size.
- LXIX.—COLLIERY BRIDGE RAILS (3 sets). Full size.
- LXX.—FINISHING ROUNDS. $3"$ to $5"$. Full size.
- LXXI.—FINISHING ROUNDS. $5\frac{3}{4}"$, $7"$, and $8\frac{1}{2}"$. Full size.
- LXXII.—BLOOMING FOR BILLETS FROM STEEL INGOTS. Scale $3" = 1$ foot. $34"$ train.
- LXXIII.—GOTHIC ROUGHING FOR LARGE ROUNDS (1st sheet). Full size.
- LXXIV.—GOTHIC ROUGHING FOR LARGE ROUNDS (1st sheet). Full size.
- LXXV.—FINISHING TEES. Full size.
- LXXVI.—FINISHING FOR STEEL FLANGE RAILS. Grooves full size.
- LXXVII.—STEEL FLANGE RAILS, 18" MILL. Full size grooves.

PLATE LXXVIII.

METHOD OF DRAWING GROOVES FOR SQUARES, DIAMONDS, GOTHICS,
ROUNDS, AND OVALS.

FIG.

- I. *Scale*, at angles of 92° and 95.5° . The horizontal lines numbered 1 to 15 represent draughts of a corresponding number of grooves for Gothic, and Diamond, roughing rolls, and relate to the angle at 95.5° only.
- II. *Diamond* grooves, as taken from scale, Fig. I., angle 95.5° . The tailoring curve for collars is drawn from a radius of one-fourth diameter of circle inscribed within the individual groove; see Fig. V.
- III. *Gothic* grooves, as taken from scale, Fig. I., angle 95.5° . For curves, see Fig. VI.
- IV. *Square-finishing* groove. On line A B draw perpendicular line F G, from point of intersection at C draw circle of diameter equal to length of side of square required. On periphery of circle draw lines parallel to A B and F G; from junction D measure distance to C, from C mark off distance C D at F and G. From point A on scale 92° , Fig. I, mark distance C D, and draw horizontal line to sides of angle (in this case the horizontal lines correspond to No. XI.), the length of this line is the width of the groove on line A B. The tailoring curves at corners A B are from a radius of one-tenth length of side of the square.
- V. *Diamond* groove. On line A B draw perpendicular line C D E. Refer to scale on Fig. I., angle 95.5° , and from horizontal line XI. (in this case) to A mark the distance D to E and C respectively. The width $a b$ is also taken from same scale on horizontal line No. XI. Draw lines from C, E, to a, b , and the diamond is formed. The tailoring curves at A, B, complete the figure: these are formed by taking a radius (D f) of one-fourth diameter of the inscribed circle.
- VI. *Gothic* groove. The depth A B and width C D are found by referring to Fig. I., angle 95.5° , No. XI. Mark off these points, and with radius A B, draw the curves A C, A D, B C, and B D, respectively. The tailoring curves at C, D, are drawn with radius (E f) of one-fourth diameter of inscribed circle.
- VII. *Round* groove. Draw horizontal line A A, and at right angles to it the line B C, and from point of intersection at O describe a circle of the required size. From a, a , with radius $a B$, draw arcs B C, and with same radius from points B, and C,

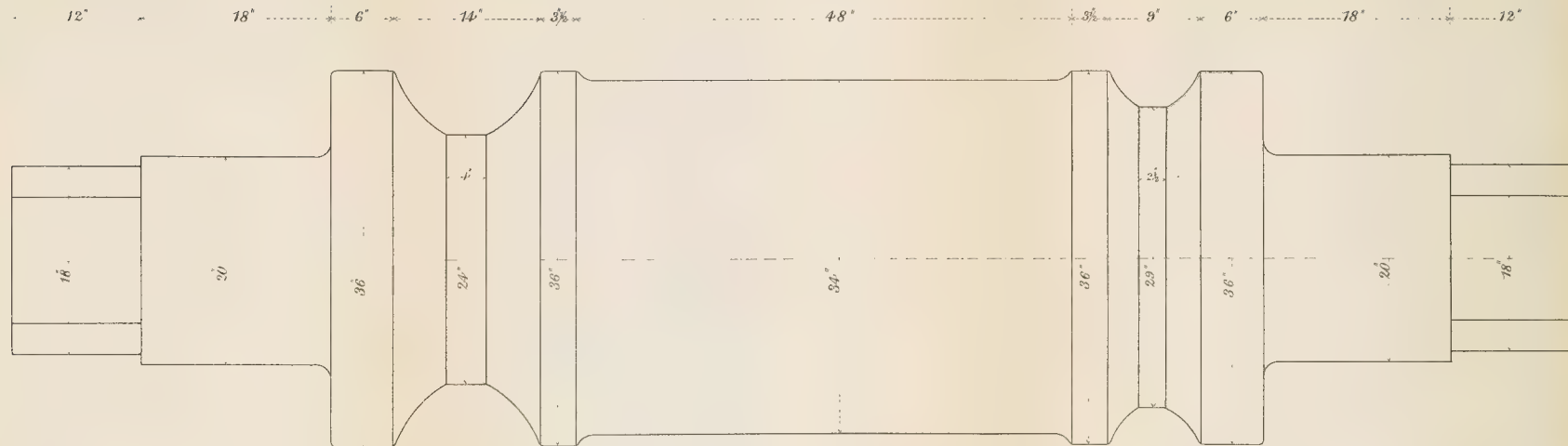
intersect these at D, E, F, G, and from these points, with radius G H, draw the opening curves H I. The tailoring curves at I are drawn with radius B, f , equal to half the distance from B to K.

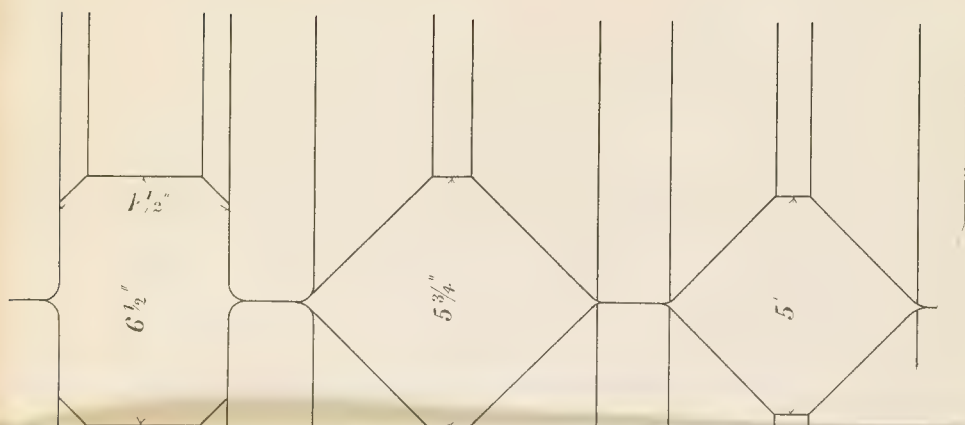
FIG.

VIII., } *Oval groove.* Fig. VIII. is the round for which the oval is intended. First draw
IX., & X. } this, and divide the diameter into three equal parts, and with radius $a b$ equal to
two of these parts draw a circle, Fig. IX. The vertical diameter F E of this circle
is also divided into three equal parts. Through C and D draw lines parallel to
the horizontal diameter A B. The sections C e F f , and D h E g , when put together,
form the oval required. Fig. X. represents the oval, and round to correspond.

BLOOM ROLL (ONE OF PAIR) FOR STEEL PLATE SLABS.

Note: Top roll arranged to lift 30 inches

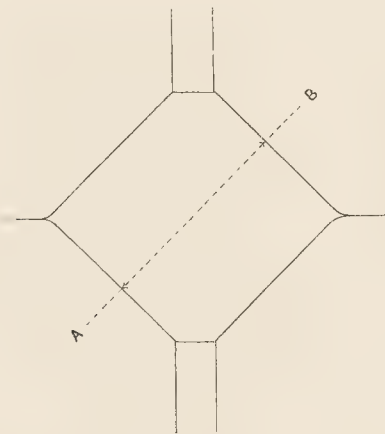
Scale $1\frac{1}{2}" = 1$ Foot

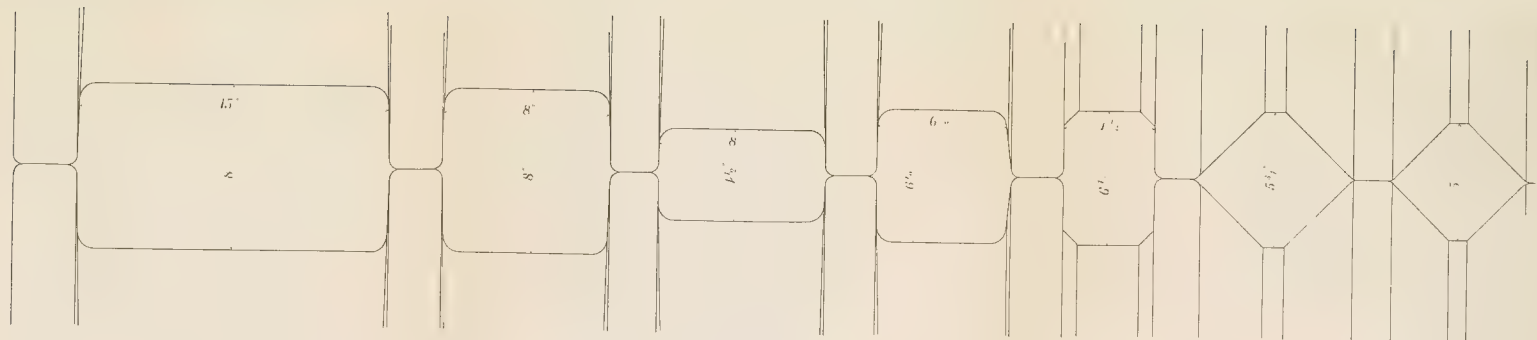


tion of Billet end.

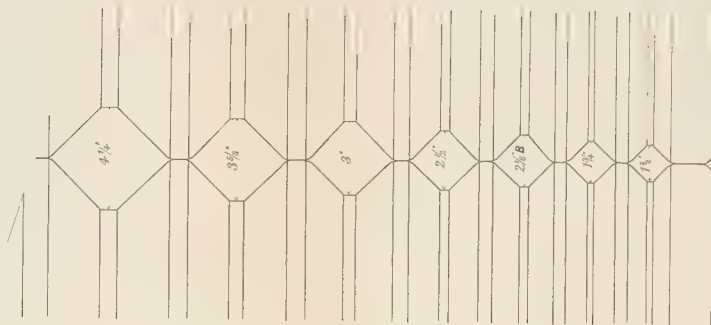
ERRATUM.

In PLATE II., dimensions for billet grooves should read not as marked, but as shown on this sketch from face to face on line A B.





To take an ingot 14' sq' at small end and 15' sq' at large end or less if preferred.
 Top Roll balanced.
 Same size of wabler and neck as bloom roll see Plate 1)



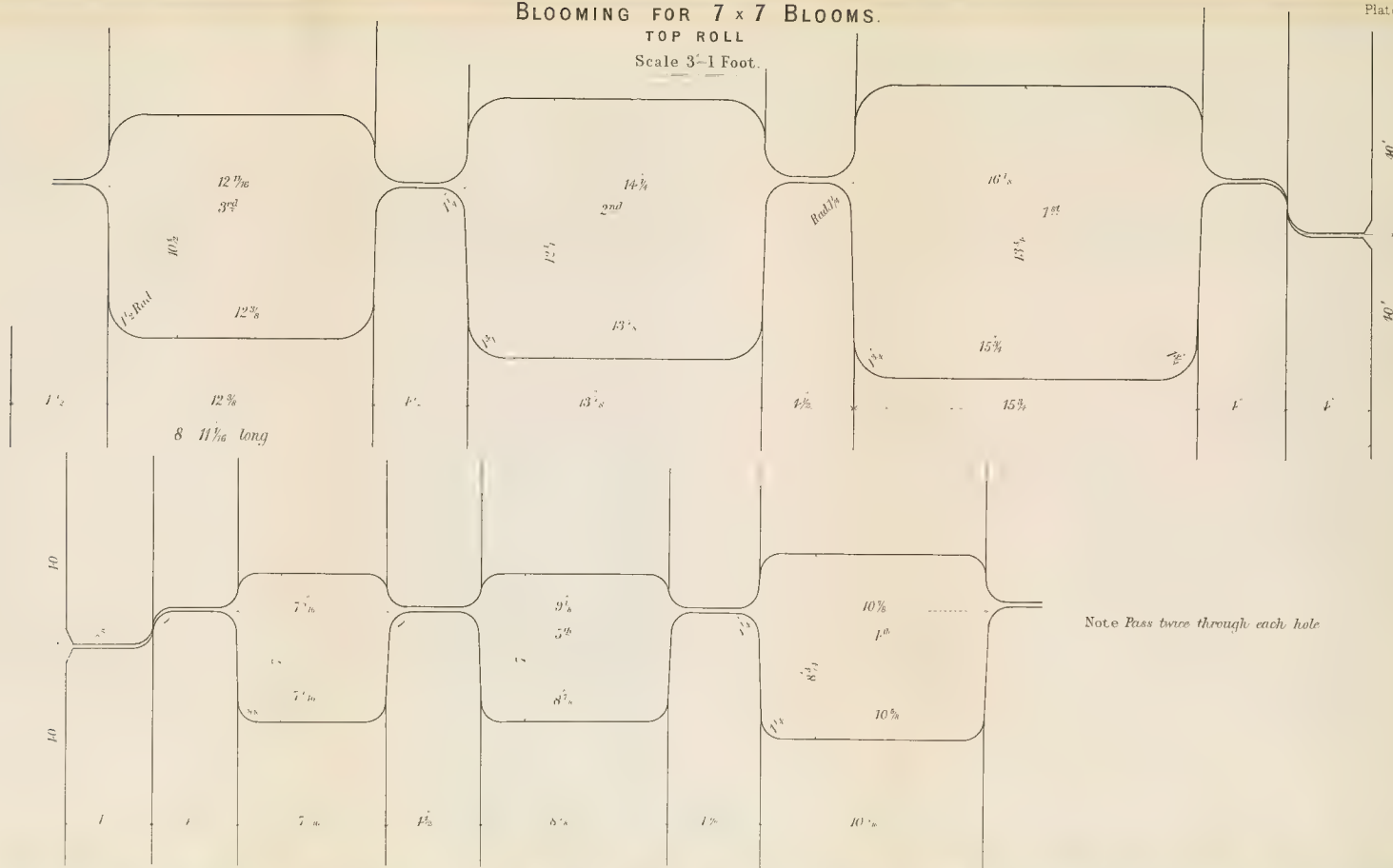
Continuation of Billet end

BLOOMING FOR 7 x 7 BLOOMS.

TOP ROLL

Scale 3"-1 Foot.

Plate III



ROUGHING FOR STEEL FLANGE RAILS

Full Size

2' 7 $\frac{1}{8}$ "

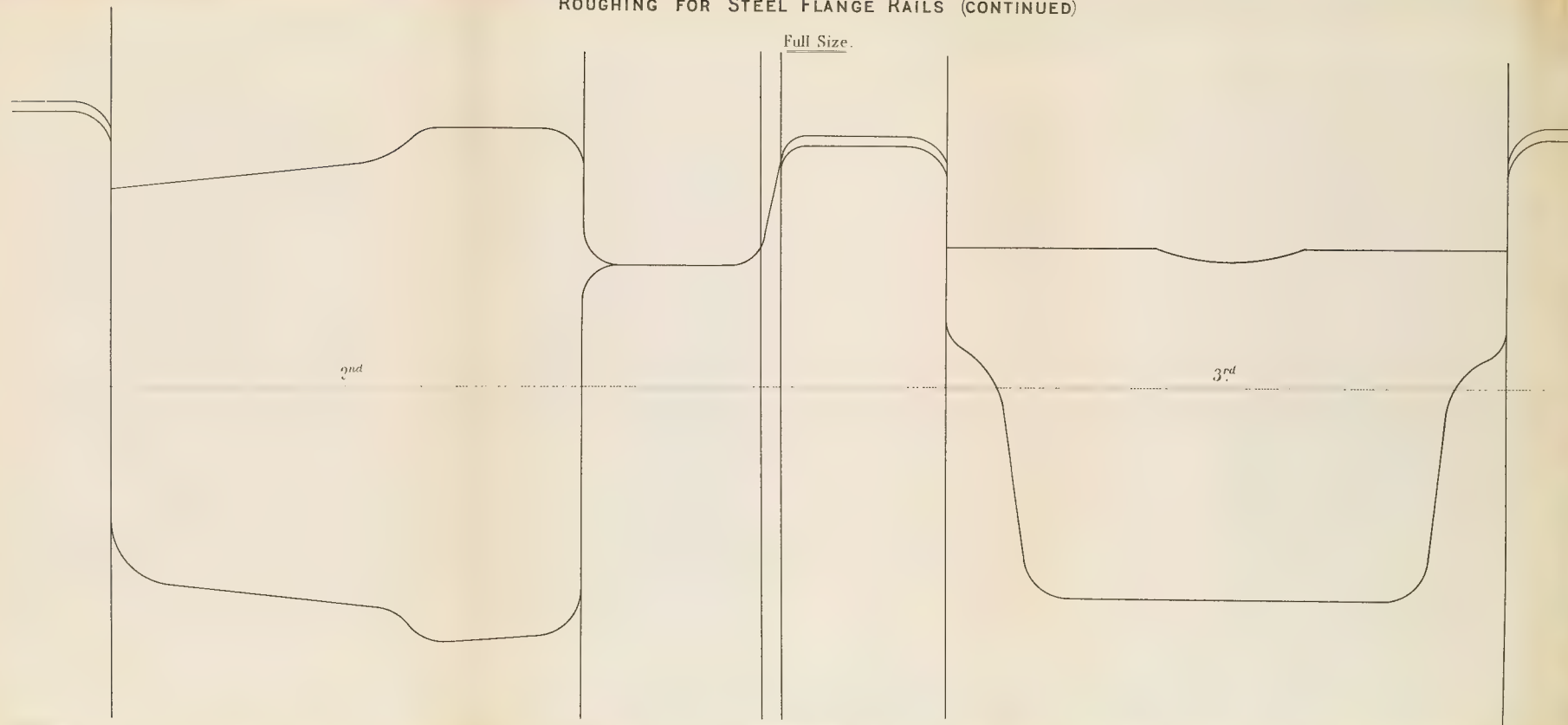
x

2' 7 $\frac{3}{8}$ "

1st

1888

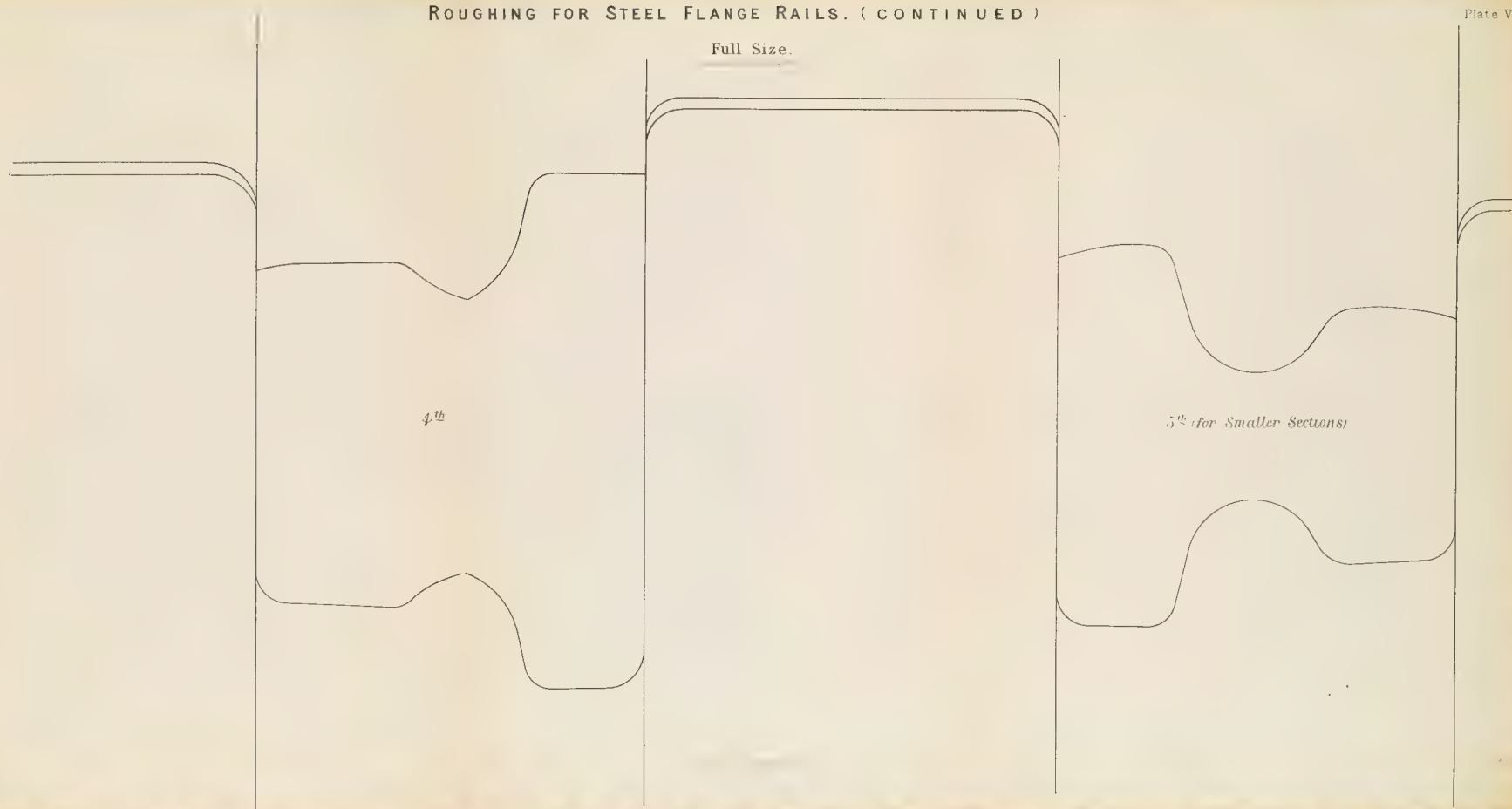
ROUGHING FOR STEEL FLANGE RAILS (CONTINUED)



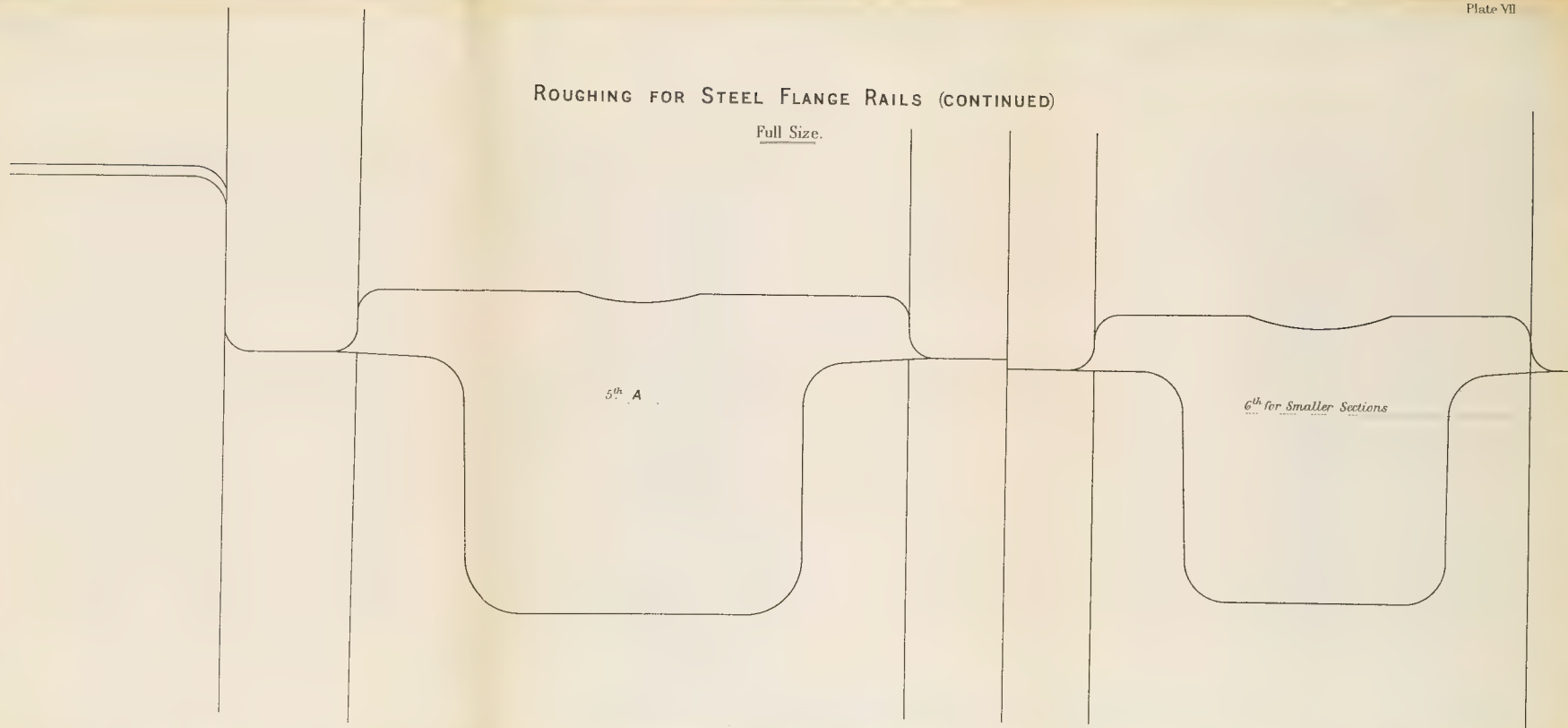
ROUGHING FOR STEEL FLANGE RAILS. (CONTINUED)

Plate VI.

Full Size.



ROUGHING FOR STEEL FLANGE RAILS (CONTINUED)

Full Size.5th A6th for Smaller Sections

LAST END

Full Size.

SPARE HOLE

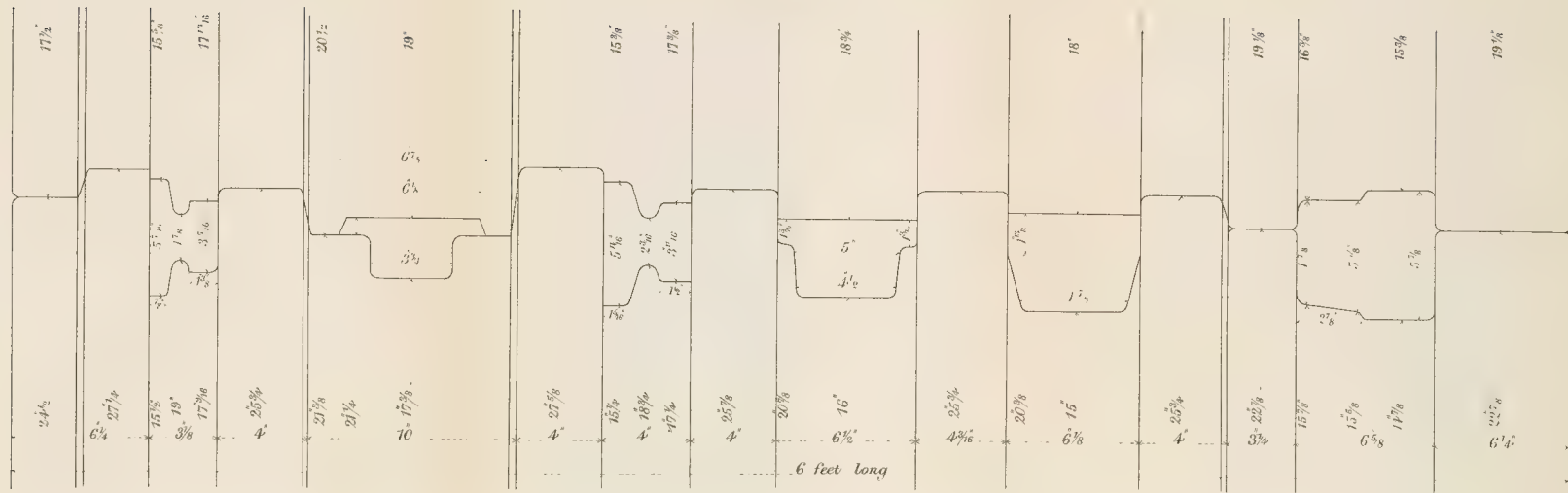
2' 7 $\frac{1}{2}$ "

73

ROUGHING ROLLS FOR 35 TO 50 LBS FLANGE RAILS.

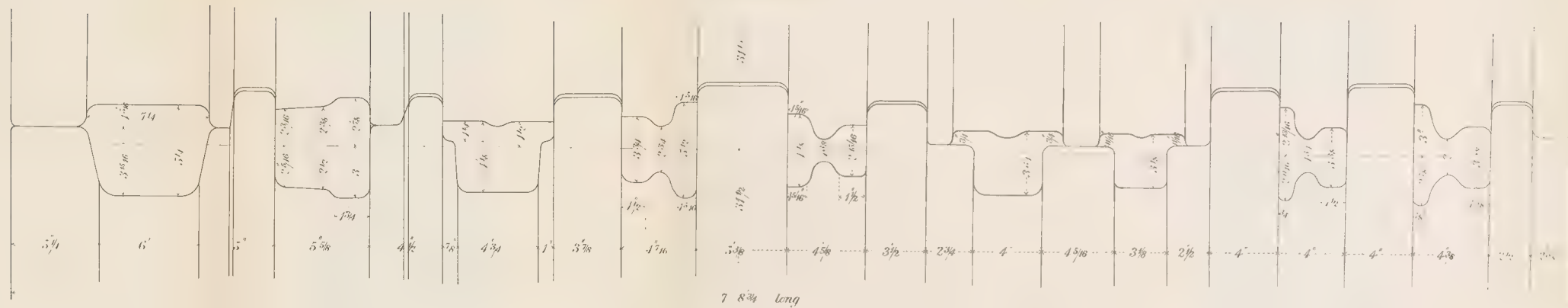
21' Train.

Scale 3'-1 Foot

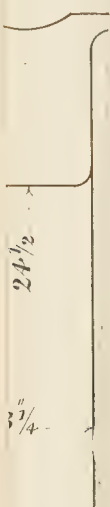


ROUGHING FOR STEEL FLANGE RAILS 30 TO 40 LBS & 40 TO 60 LBS PER YARD.

Scale 3" = 1 Foot

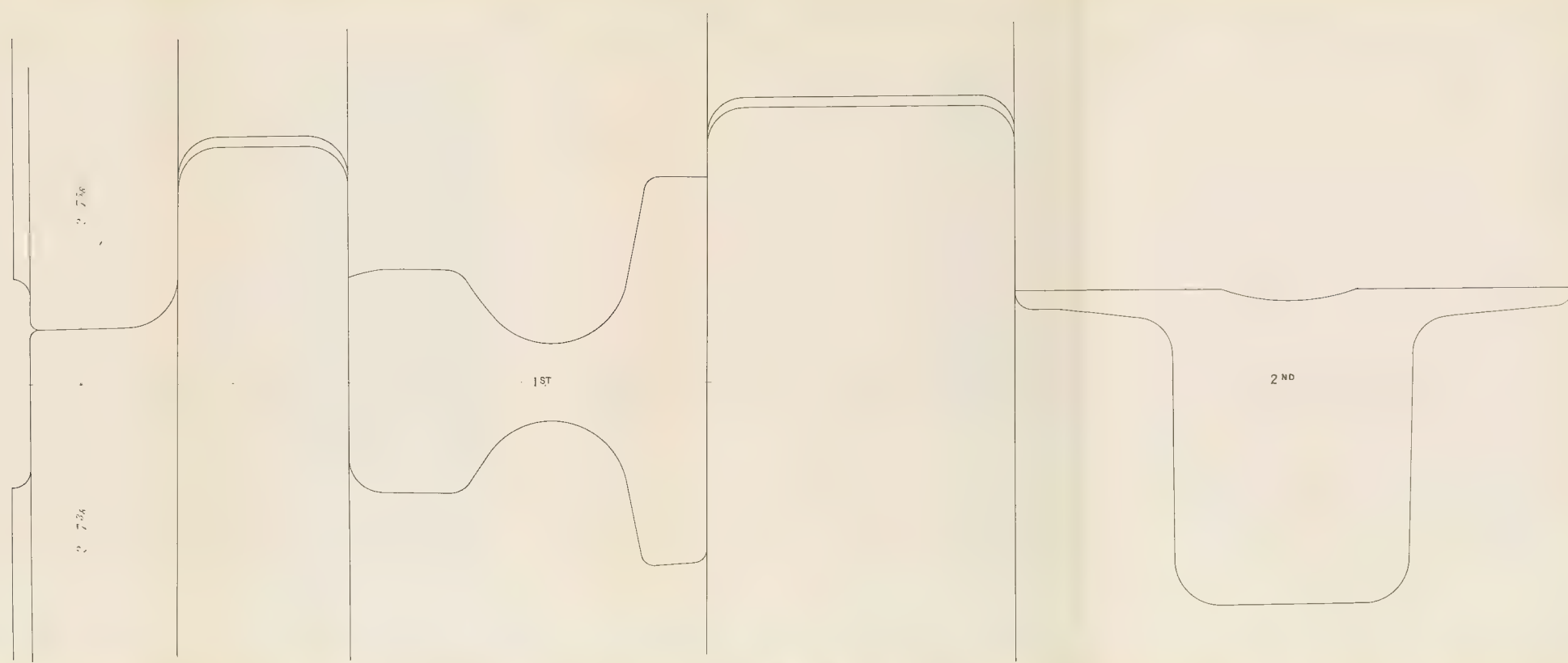


1' 6"

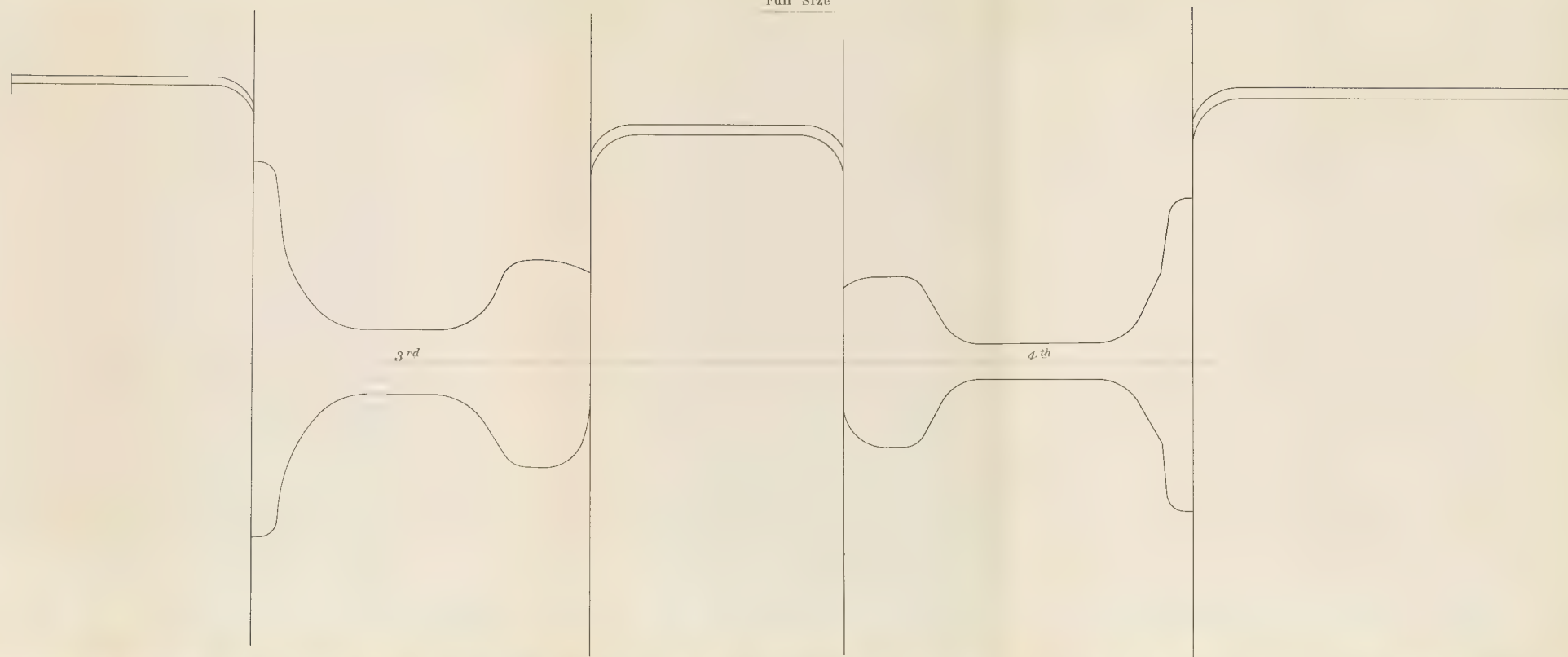


$3\frac{3}{4}$

FINISHING ROLLS, STEEL FLANGE RAILS . FULL SIZE.

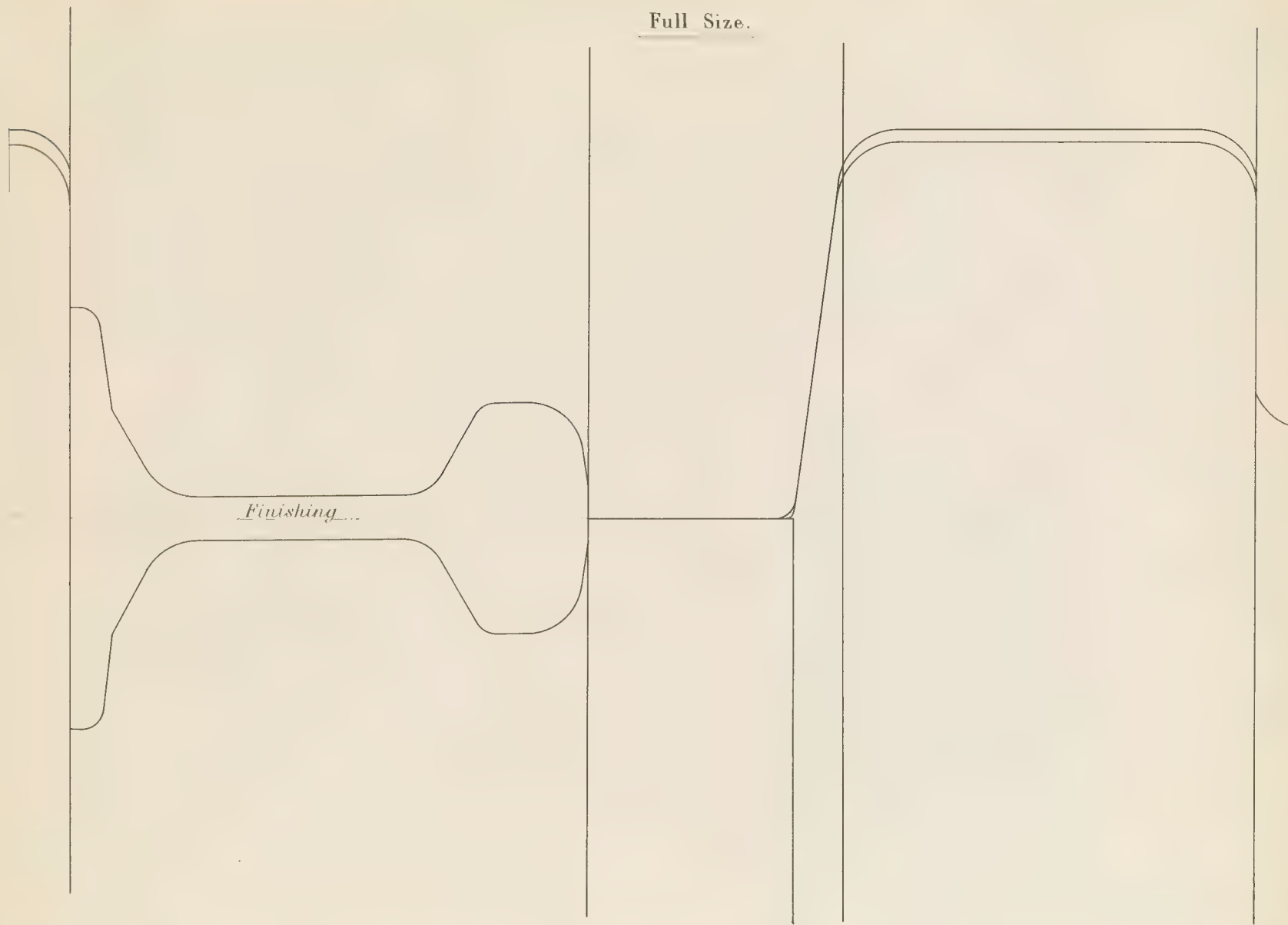


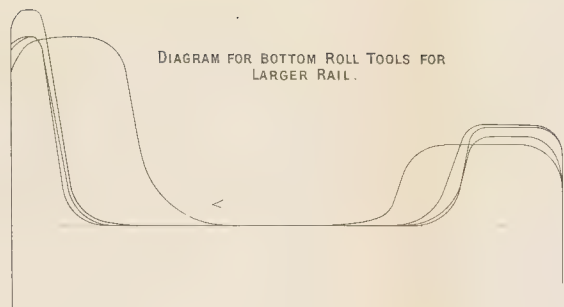
FINISHING ROLLS FOR STEEL FLANGE RAILS. (CONTINUED)

Full Size

FINISHING ROLLS, FOR STEEL FLANGE RAILS. (CONTINUED)

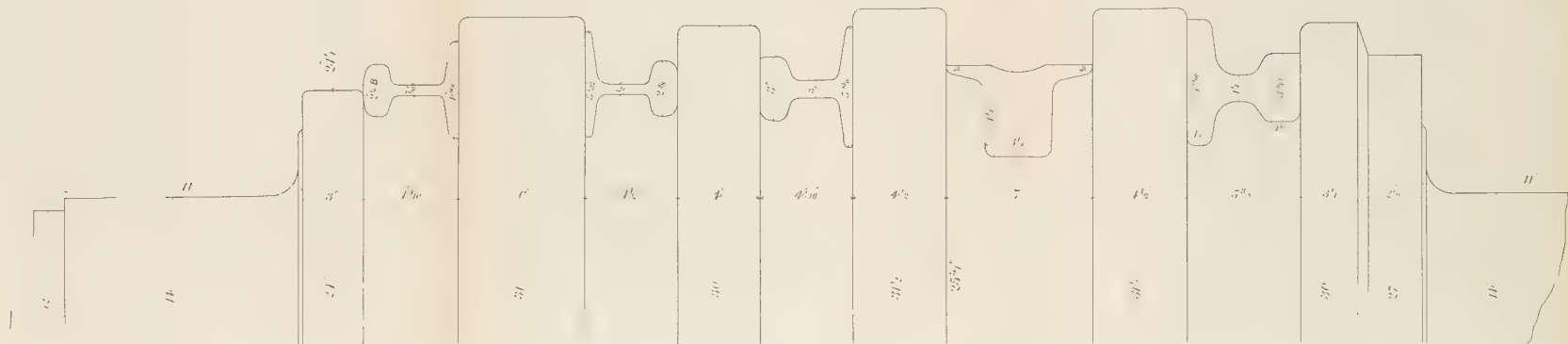
Full Size.





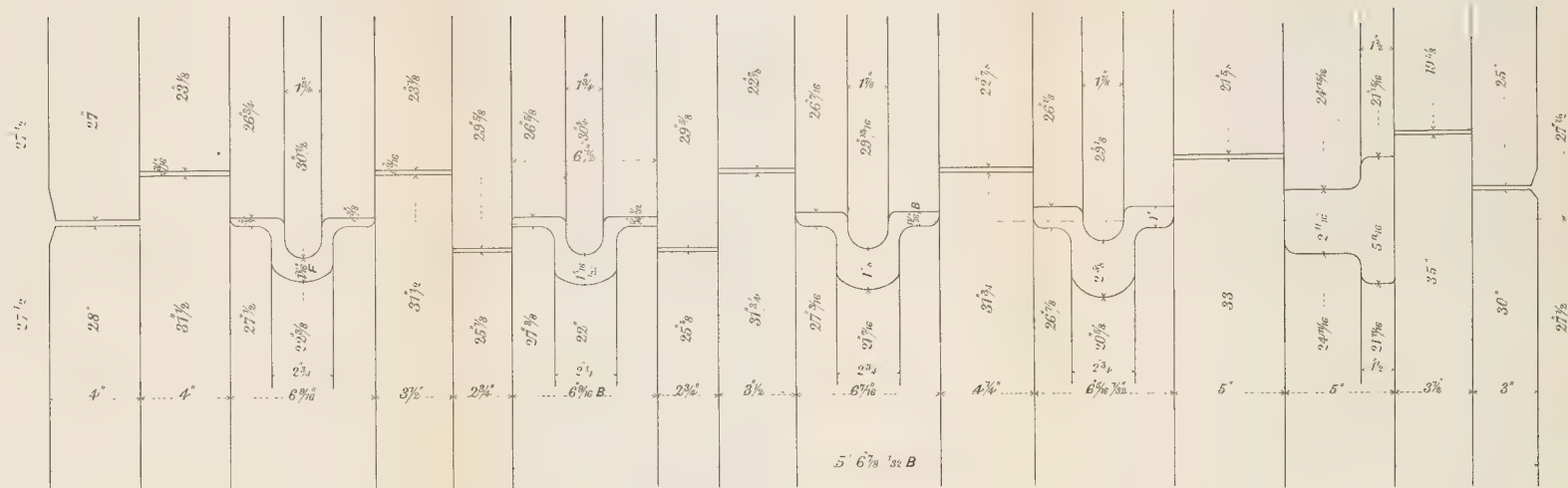
ROLL TURNING

ROLLS FOR STEEL FLANGE RAILS 4' 6" LONG 24" CENTRES— $\frac{1}{4}$ SCALE.



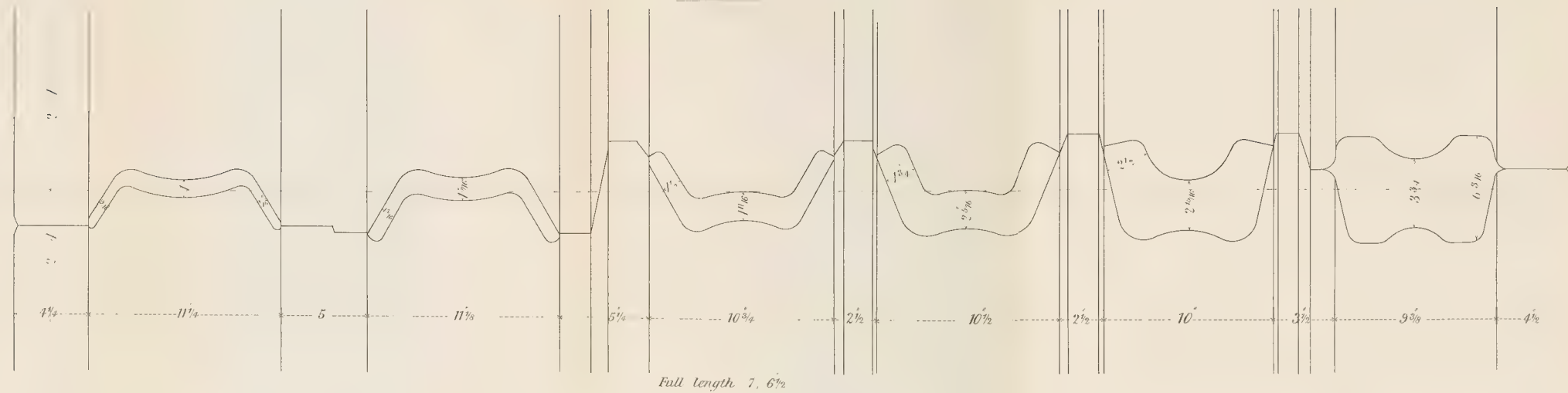
FINISHING BRIDGE RAILS (74 LBS. PER YD.)

Scale 3" = 1 Foot.



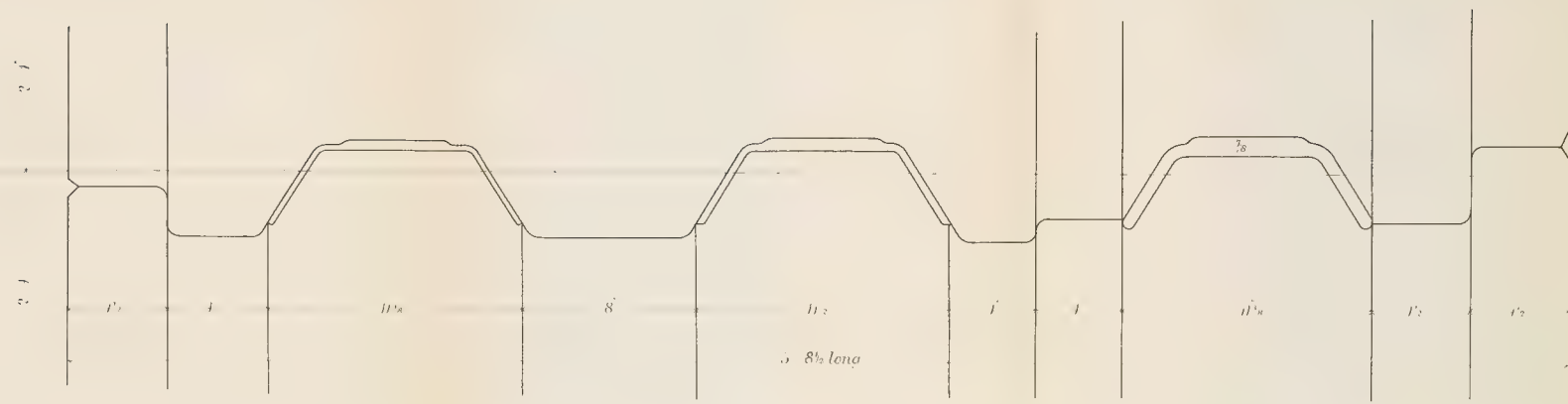
STEEL RAILWAY SLEEPERS ROUGHING ROLLS TOP ROLL.

Scale 3" = 1 Foot



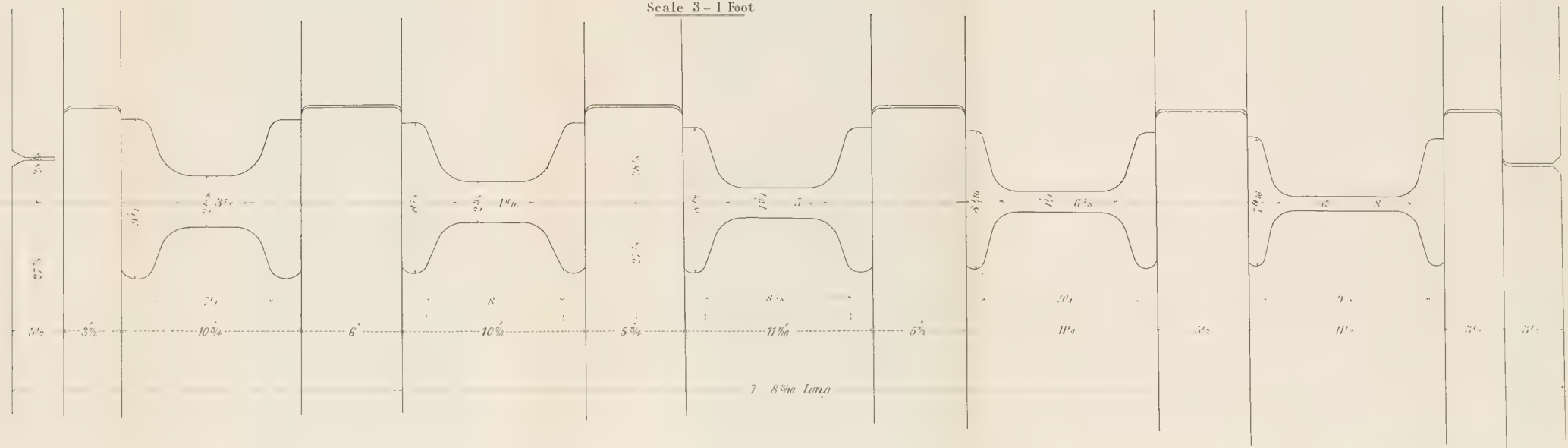
STEEL RAILWAY SLEEPERS FINISHING.

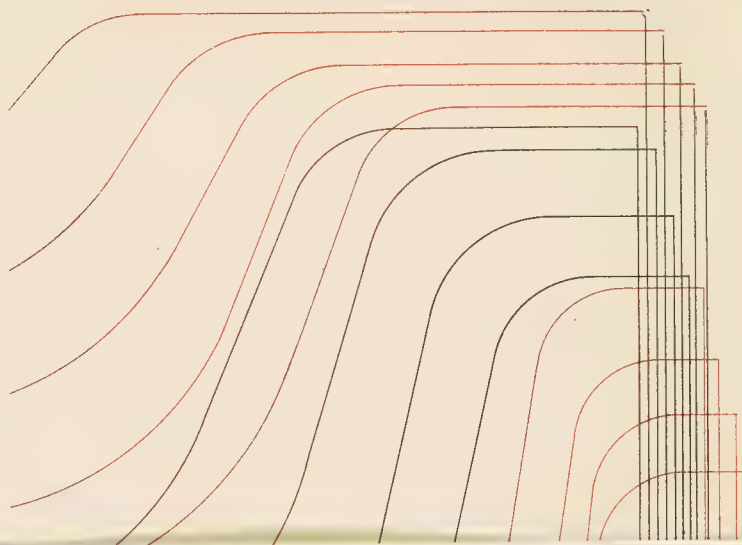
TOP ROLL

Scale 3-1 Foot

ROUGHING FOR 12" STEEL GIRDERS

Scale 3 - 1 Foot

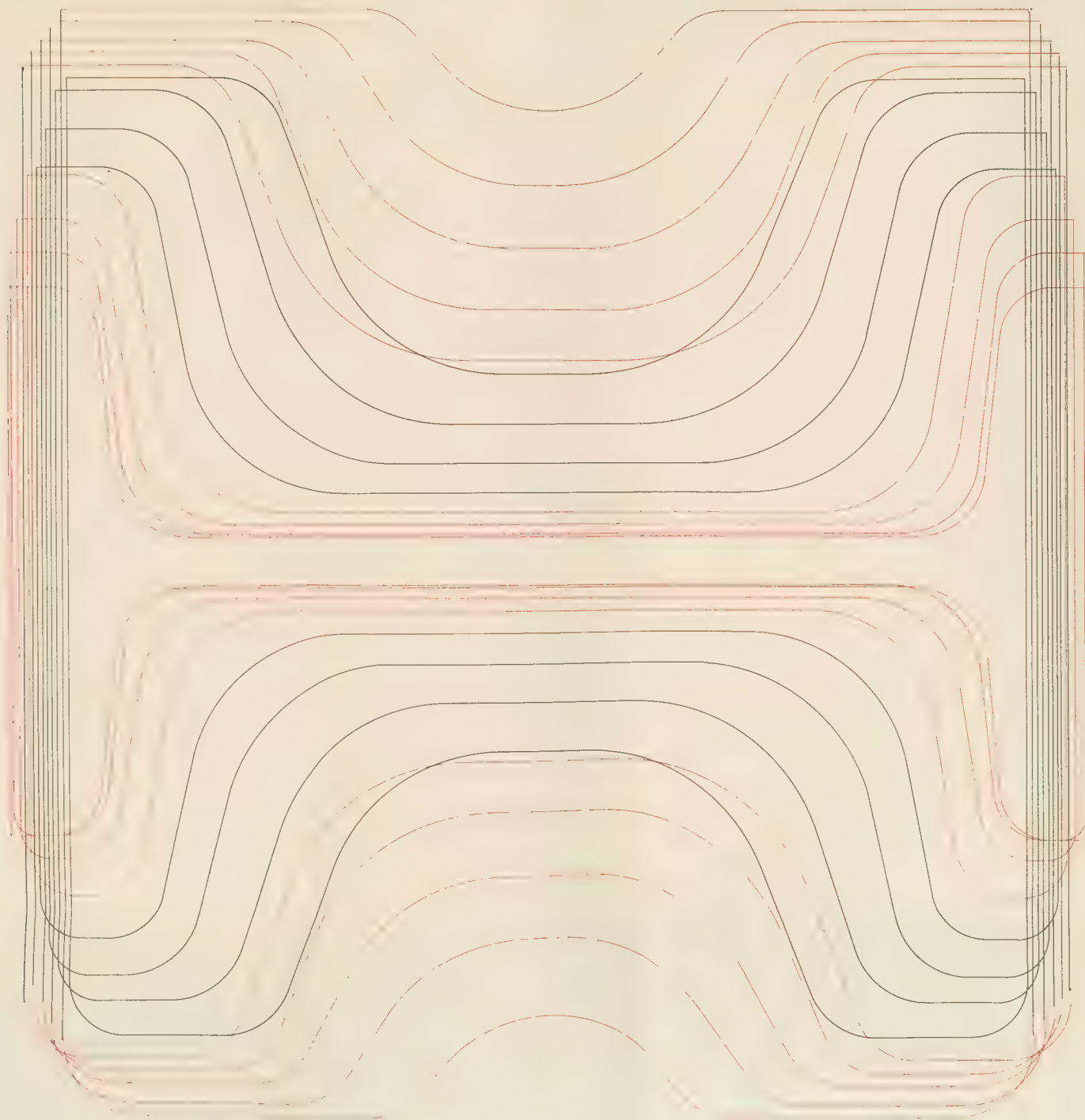




ERRATUM.

PLATE XXIII.

NOTE.—The width of grooves in blooming should be less than those in the roughing, and those of the roughing less than the finishing, and *not* as shown on drawing. This necessary "*spread*" every roll-turner will provide for. See Plates XIX., XX., and XXI.; 12" girders.

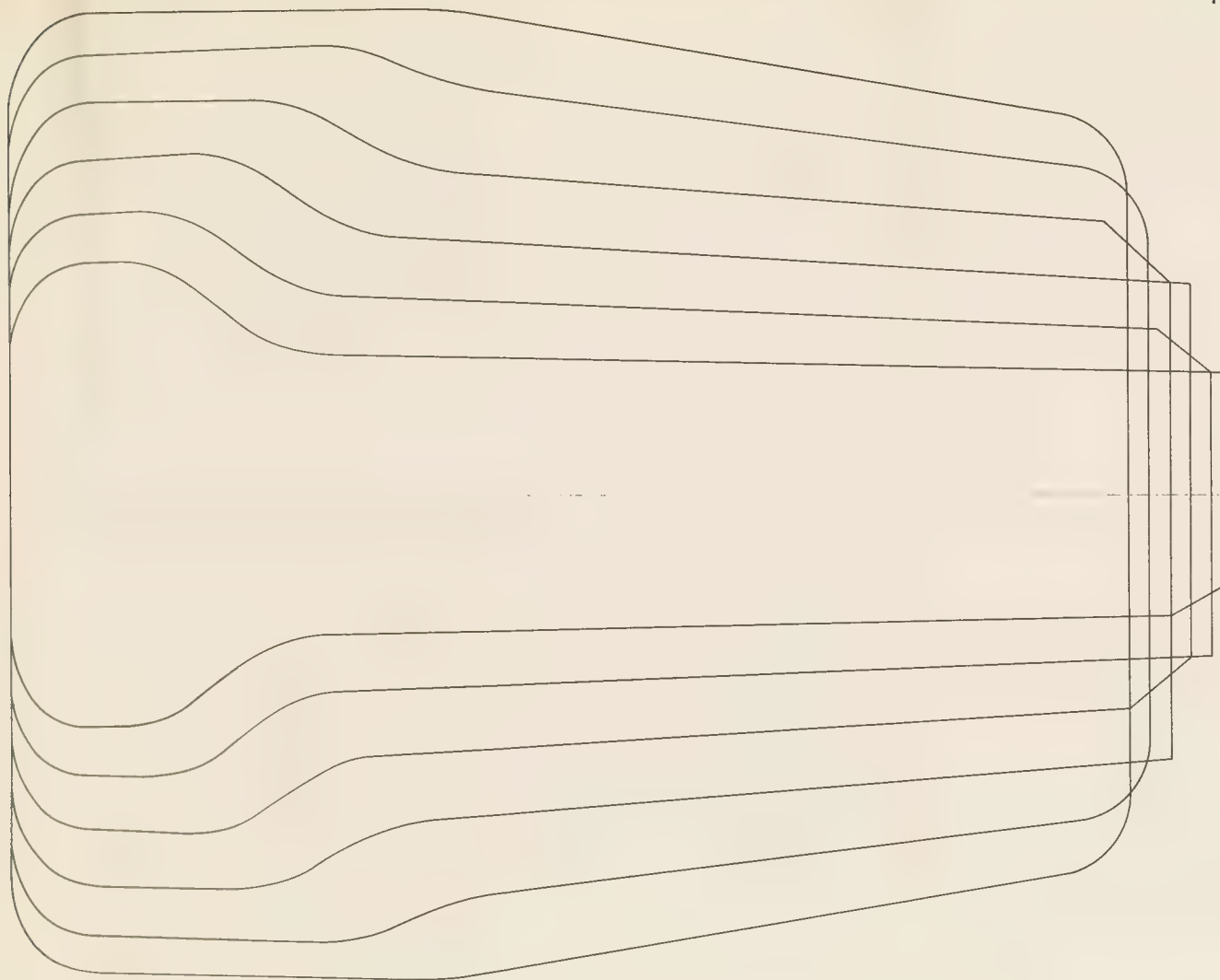


BLOOMING, ROUGHING, & FINISHING, FOR 11" x 5½" GIRDERS (STEEL)

26" ROUGHING FOR 11" STEEL BULBS.

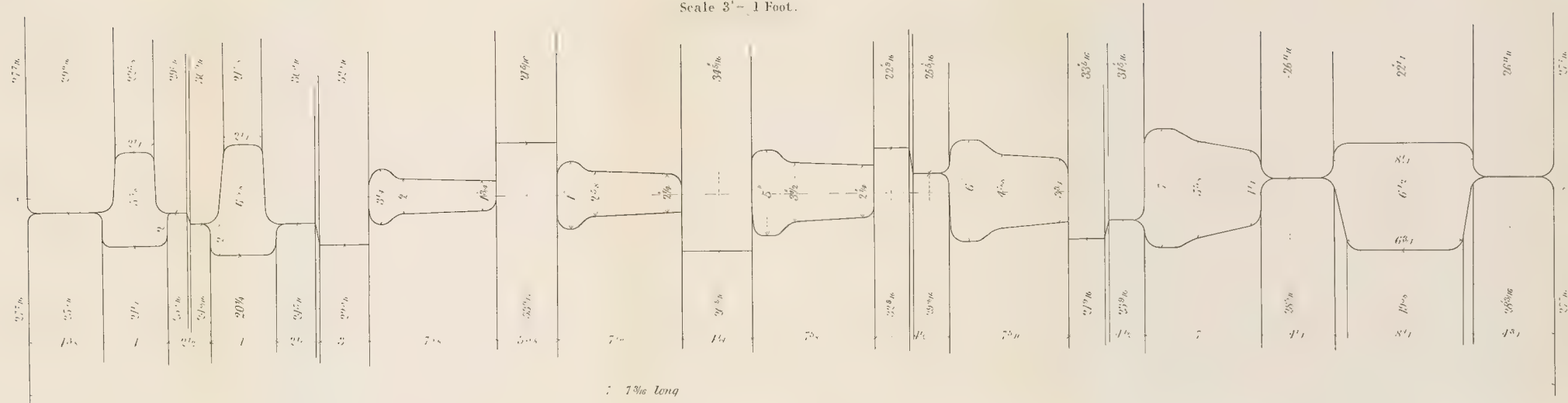
Plate XXIV.

ROUGHING FOR $8\frac{1}{2}$ " TO $10\frac{1}{2}$ "
BULBS.



ROUGHING FOR 6' 6½, 7' 7½ & 8' STEEL BULBS.

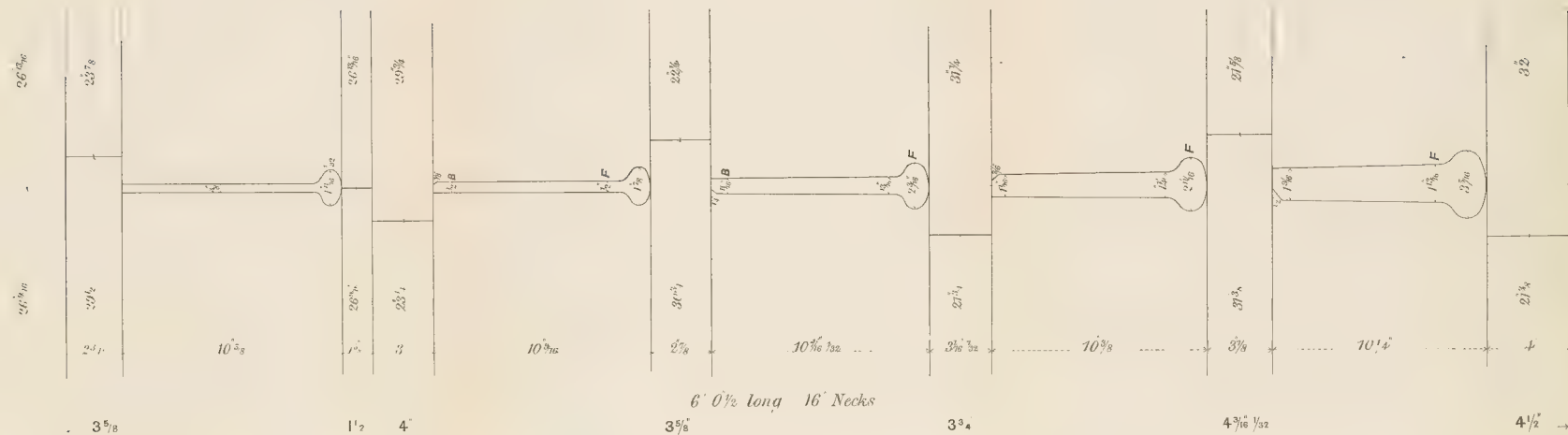
Scale 3' = 1 Foot.



FINISHING FOR $10\frac{1}{2}'' \times \frac{1}{2}''$ STEEL BULBS,

Scale 3" = 1 Foot.

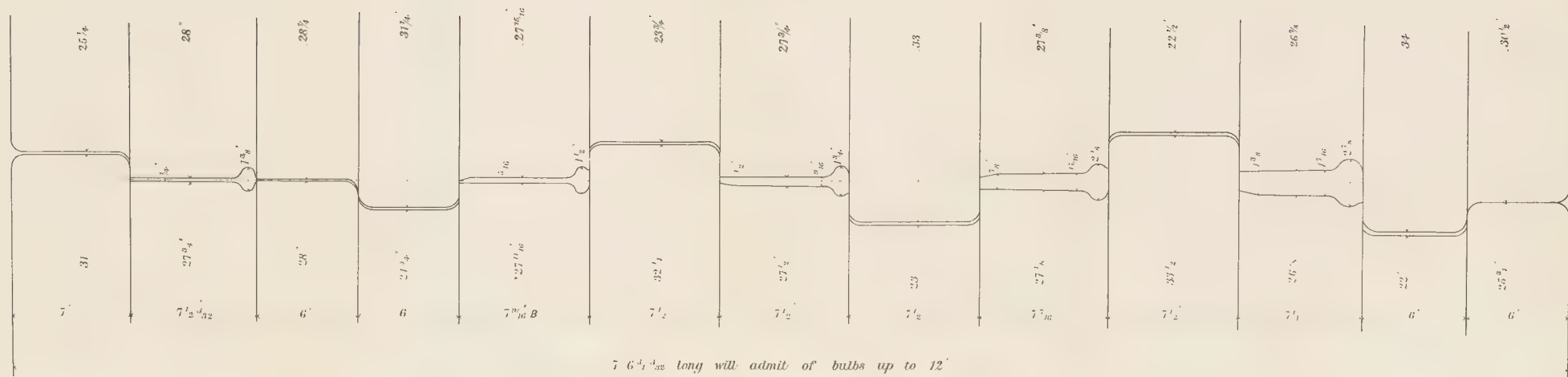
Stalk

 Note: $10\frac{1}{2}'' \times \frac{1}{2}'' \times 1\frac{1}{4}''$ head
 $9\frac{1}{2}'' \times \frac{1}{2}'' \times 1\frac{1}{4}''$ B do

 Note: Callouts for $9\frac{1}{2}''$ Bulbs in block figures as above

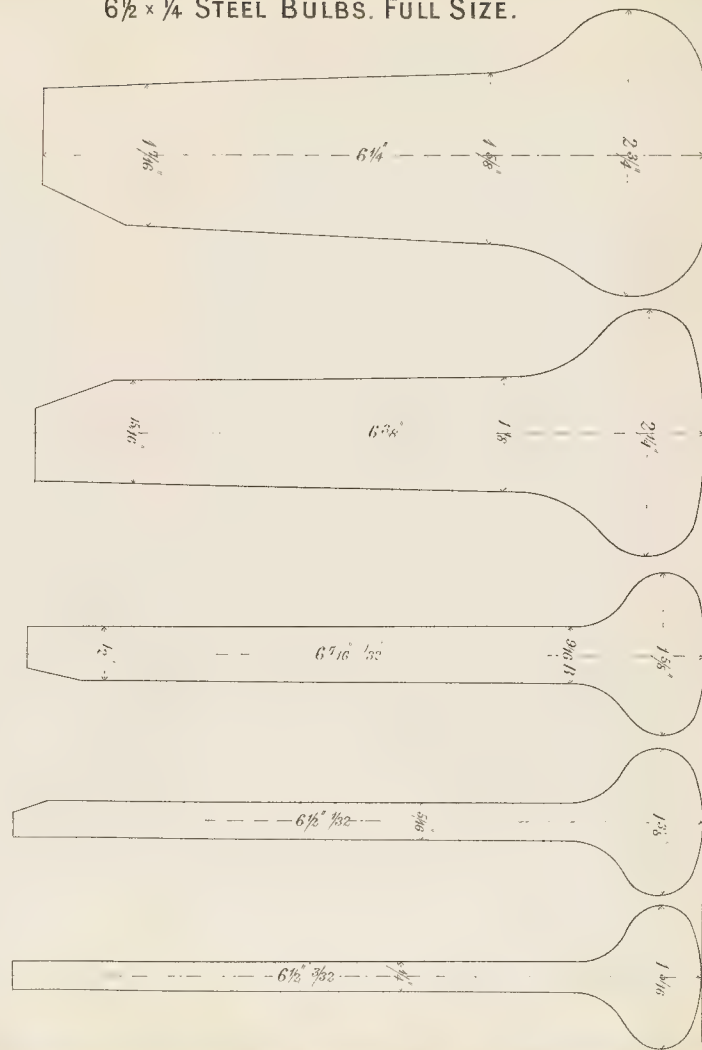
$7\frac{1}{2} \times \frac{1}{4}$ STEEL BULBS.

See note below

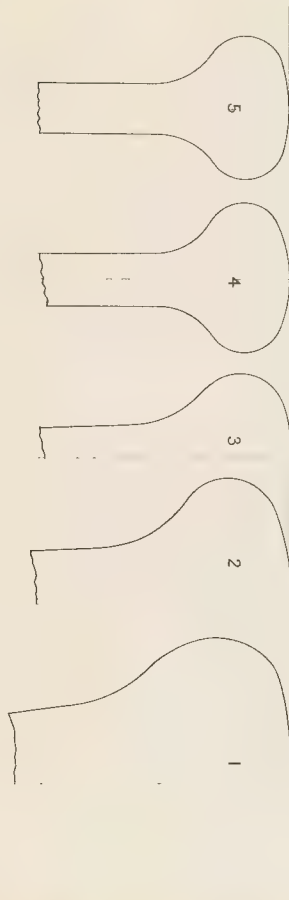
Scale 3-1 Foot



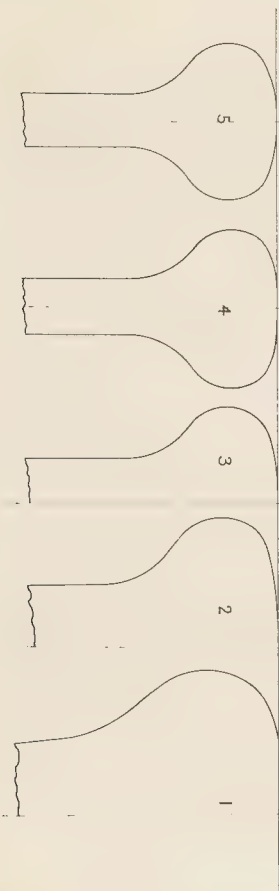
$6\frac{1}{2} \times \frac{1}{4}$ STEEL BULBS. FULL SIZE.



$7\frac{1}{2}$ BULBS (STEEL)

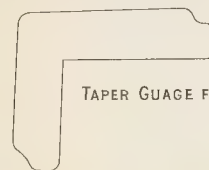
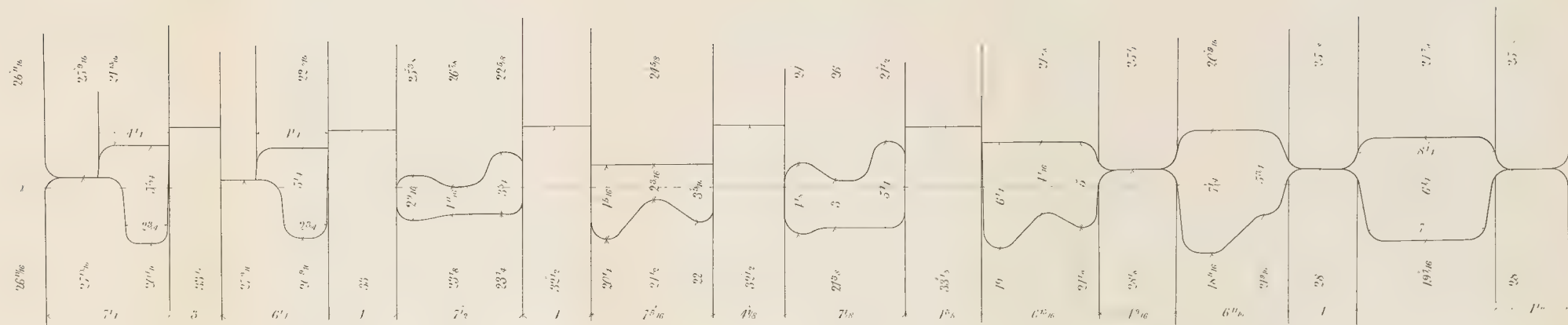


8" STEEL BULBS



BULB ANGLE ROUGHING.

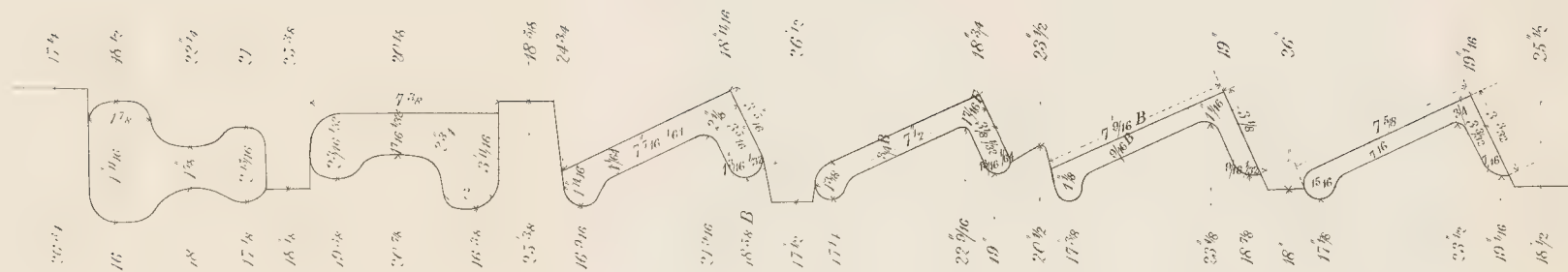
Scale 3 - 1 Foot.



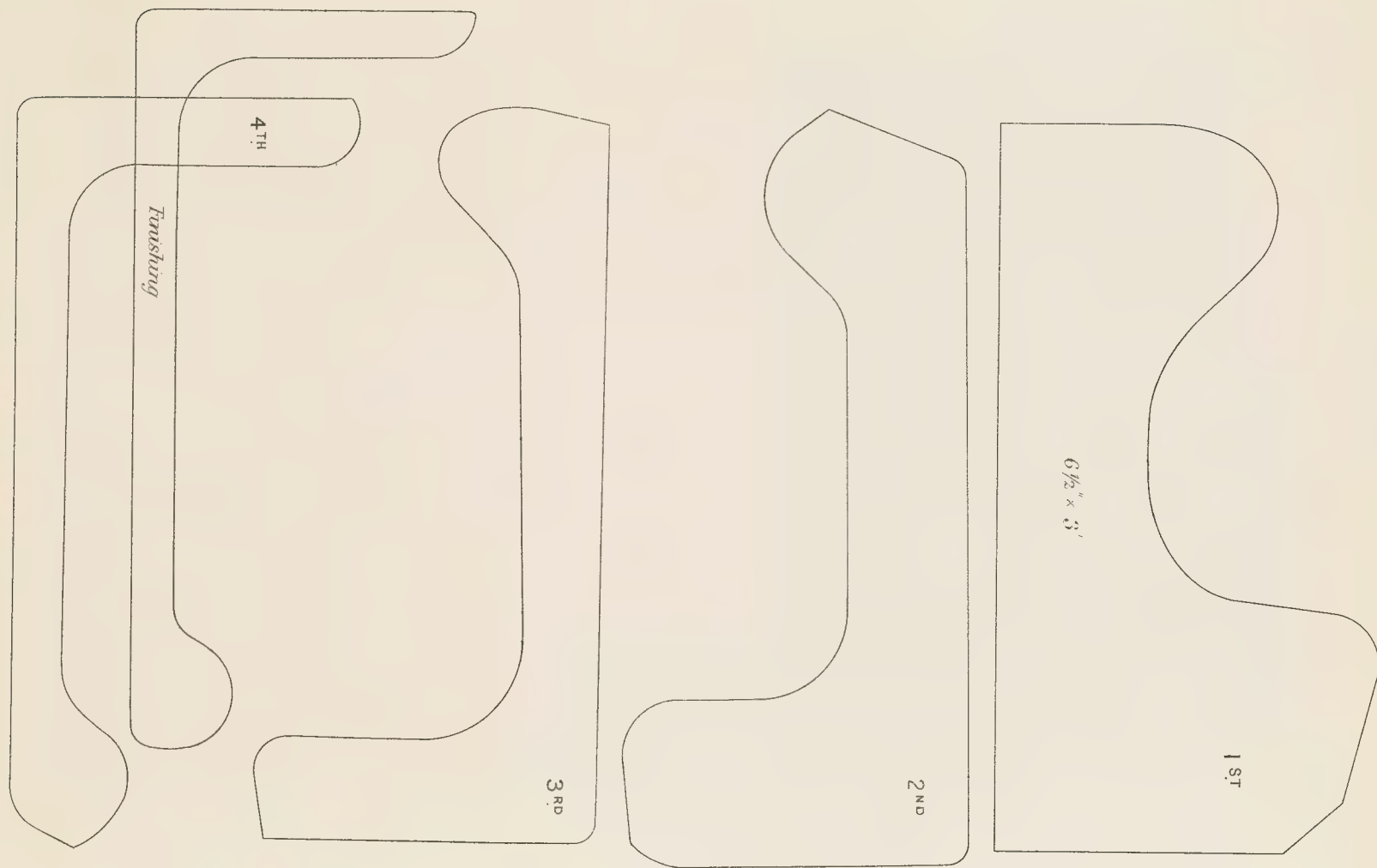
TAPER GAUGE FOR COLLARS (FULL SIZE)

BULB ANGLES $7\frac{1}{2} \times 3$.

Scale 3'-1 Foot.



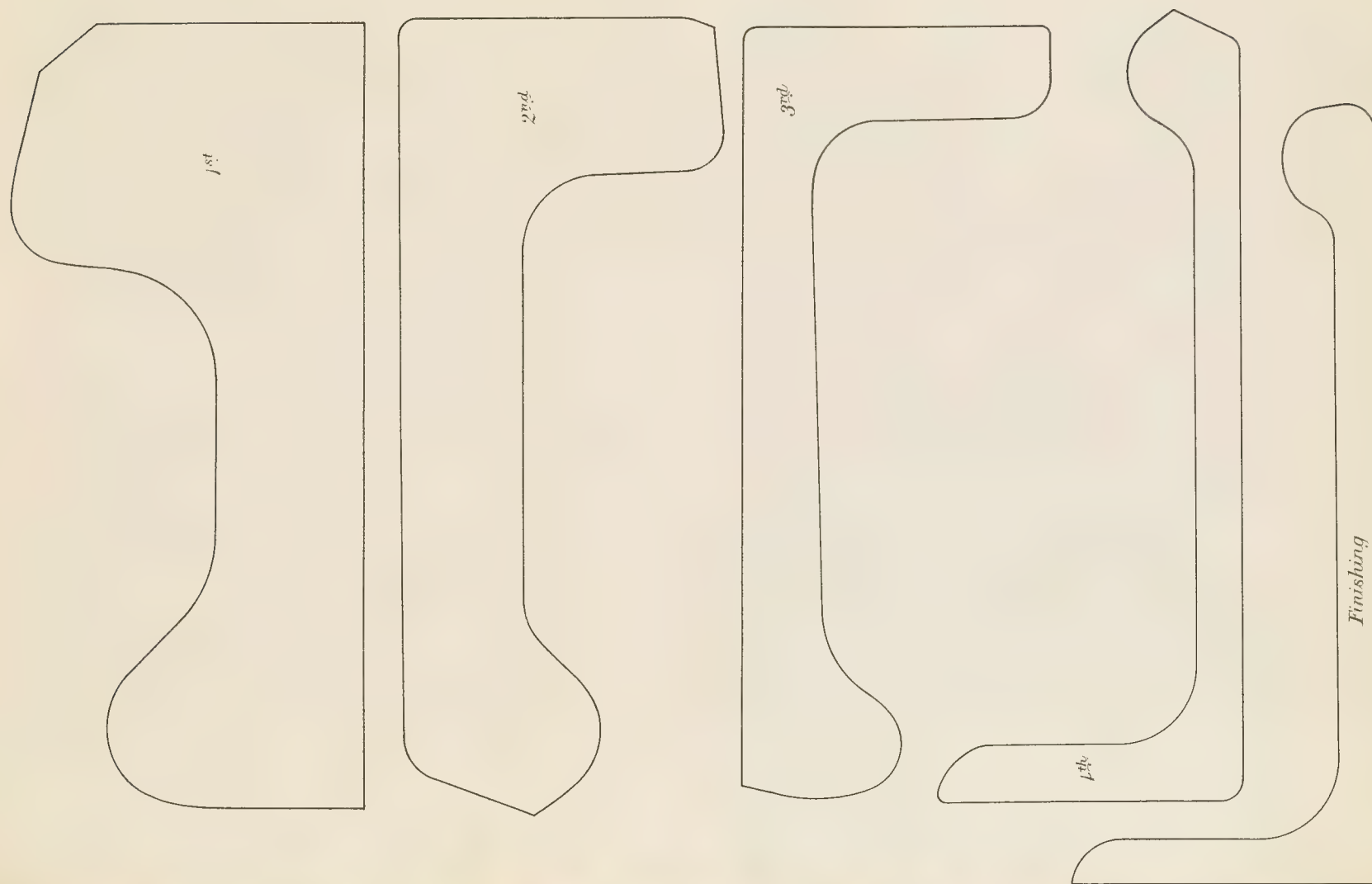
$6\frac{1}{2} \times 3'$ BULB ANGLES. FULL SIZE.



$7\frac{1}{2} \times 3$ BULB ANGLES.

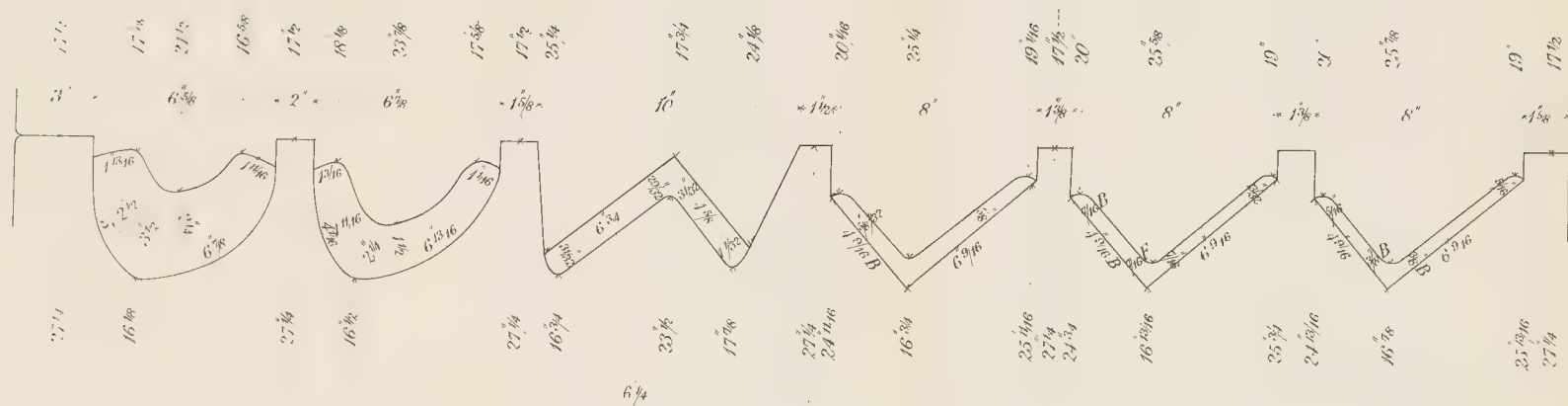
Plate XXXIV.

Full Size



6½ x 4½ ANGLES.

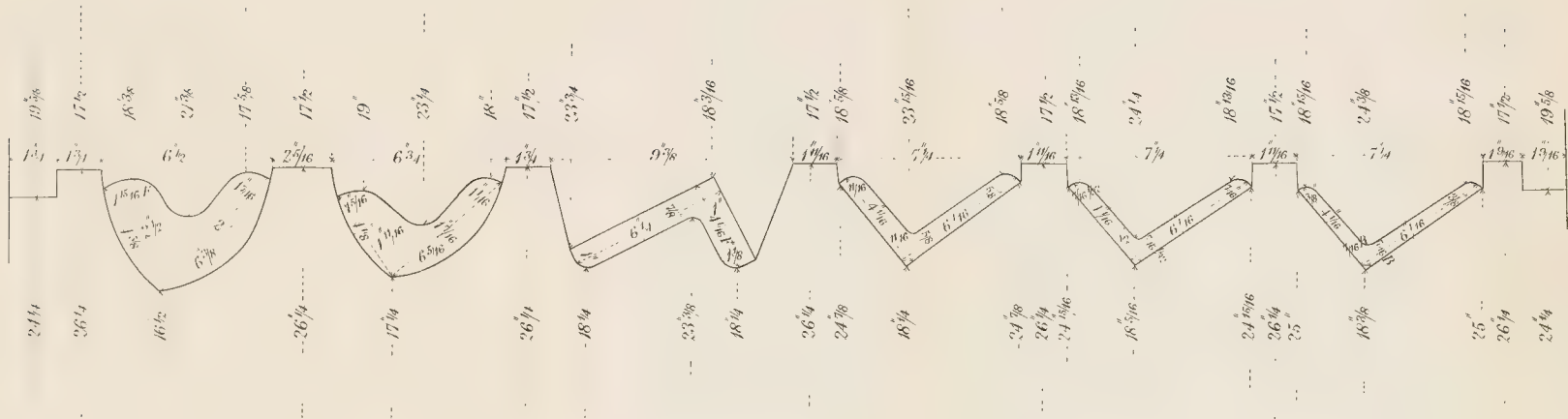
Scale 3'-1 Foot.



6' x 4' ANGLES.

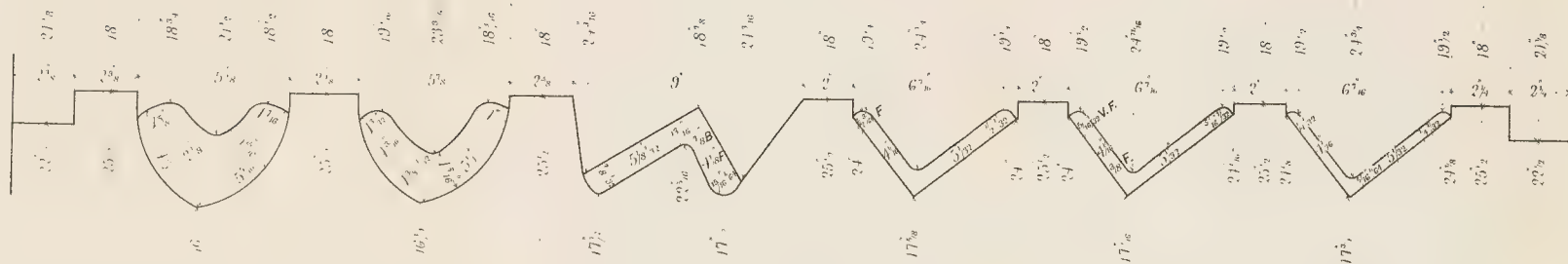
Plate XXXVIII

Scale, 3"-1 Foot



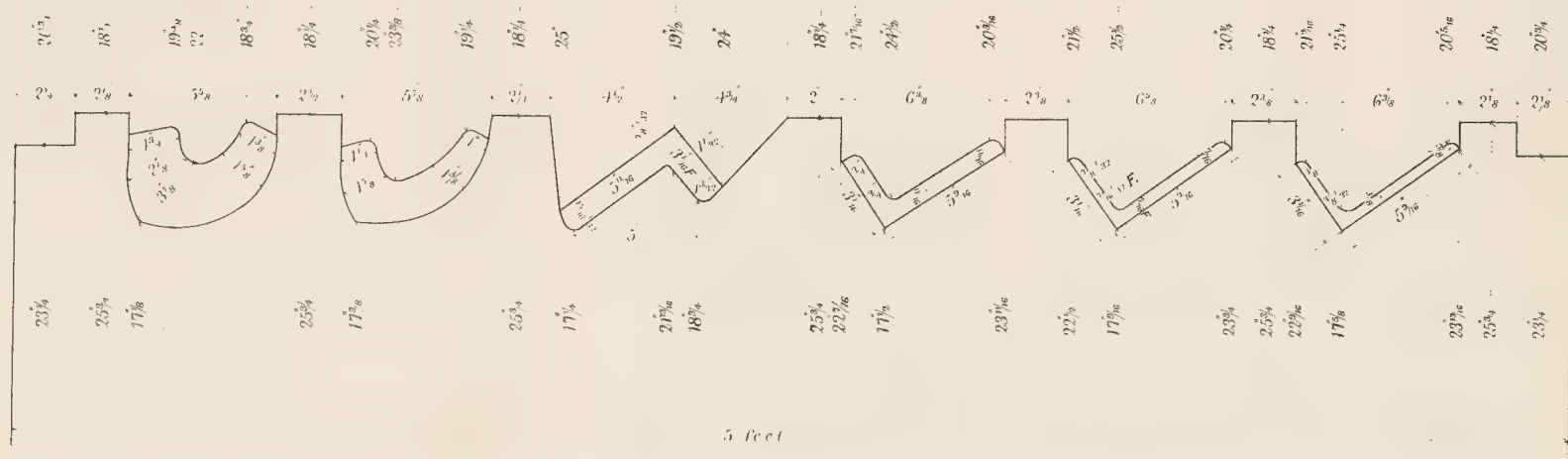
5° x 4° ANGLES.

Scale 3" = 1 Foot.

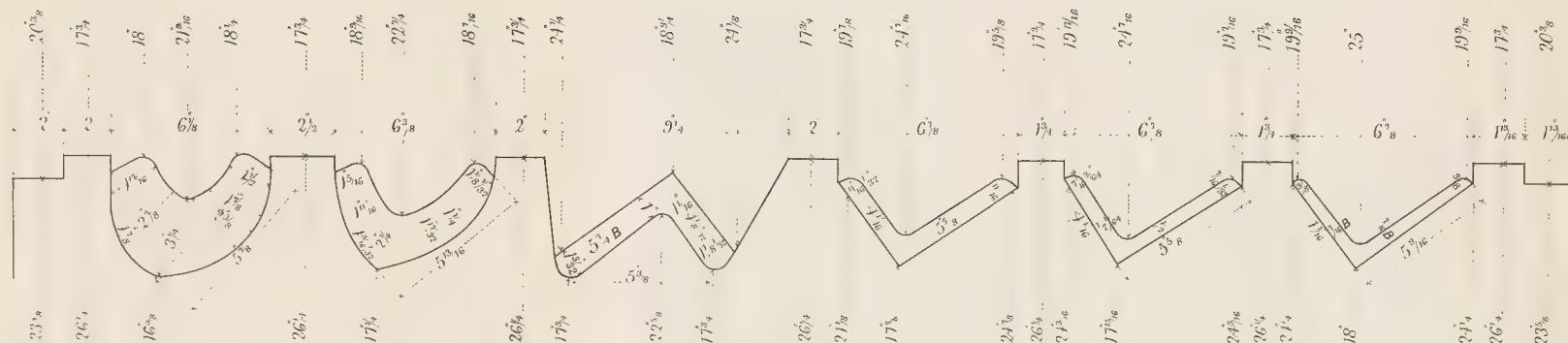


5½" x 3" ANGLES.

Scale 3" = 1 Foot.

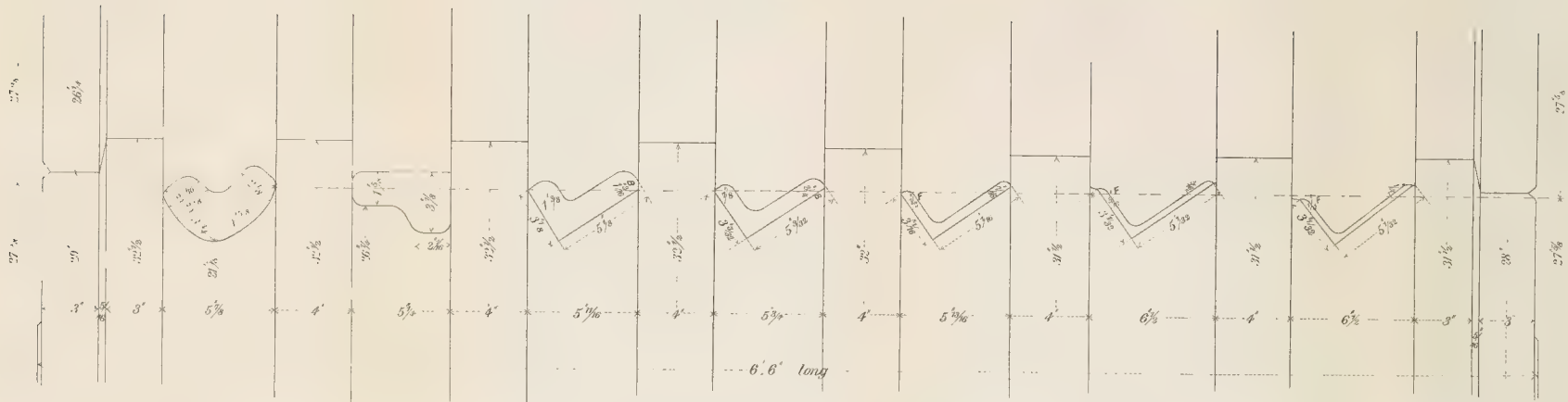


$5\frac{1}{2} \times 4$ ANGLES.

Scale 3-1 Foot.


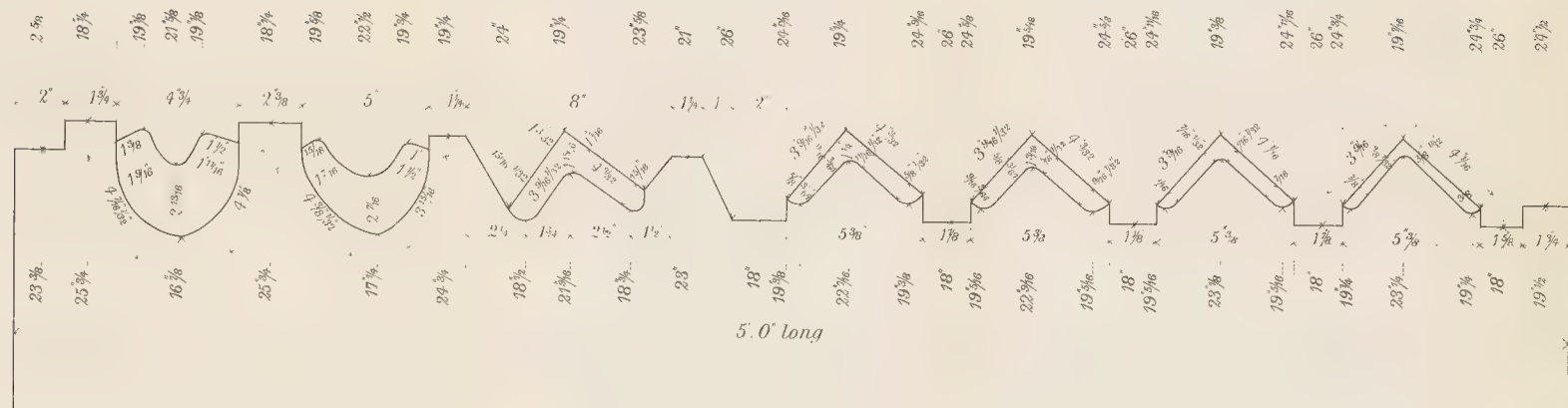
5' x 3' ANGLES.

Scale 3 - 1 Foot.



4" x 3½" ANGLES. TOP ROLL.

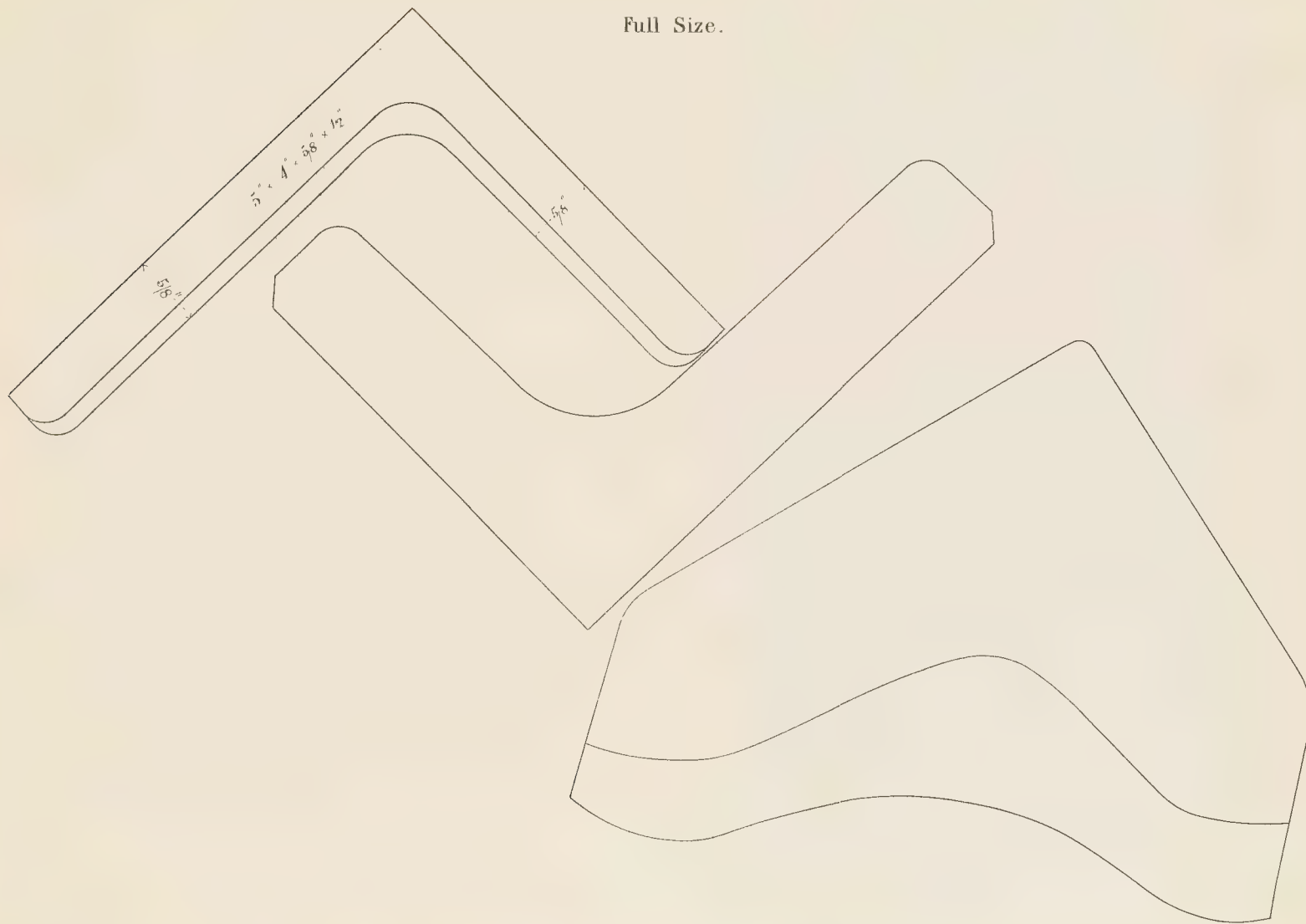
Scale 3"-1 Foot.



5" x 4" ANGLES.

Plate XLVI

Full Size.

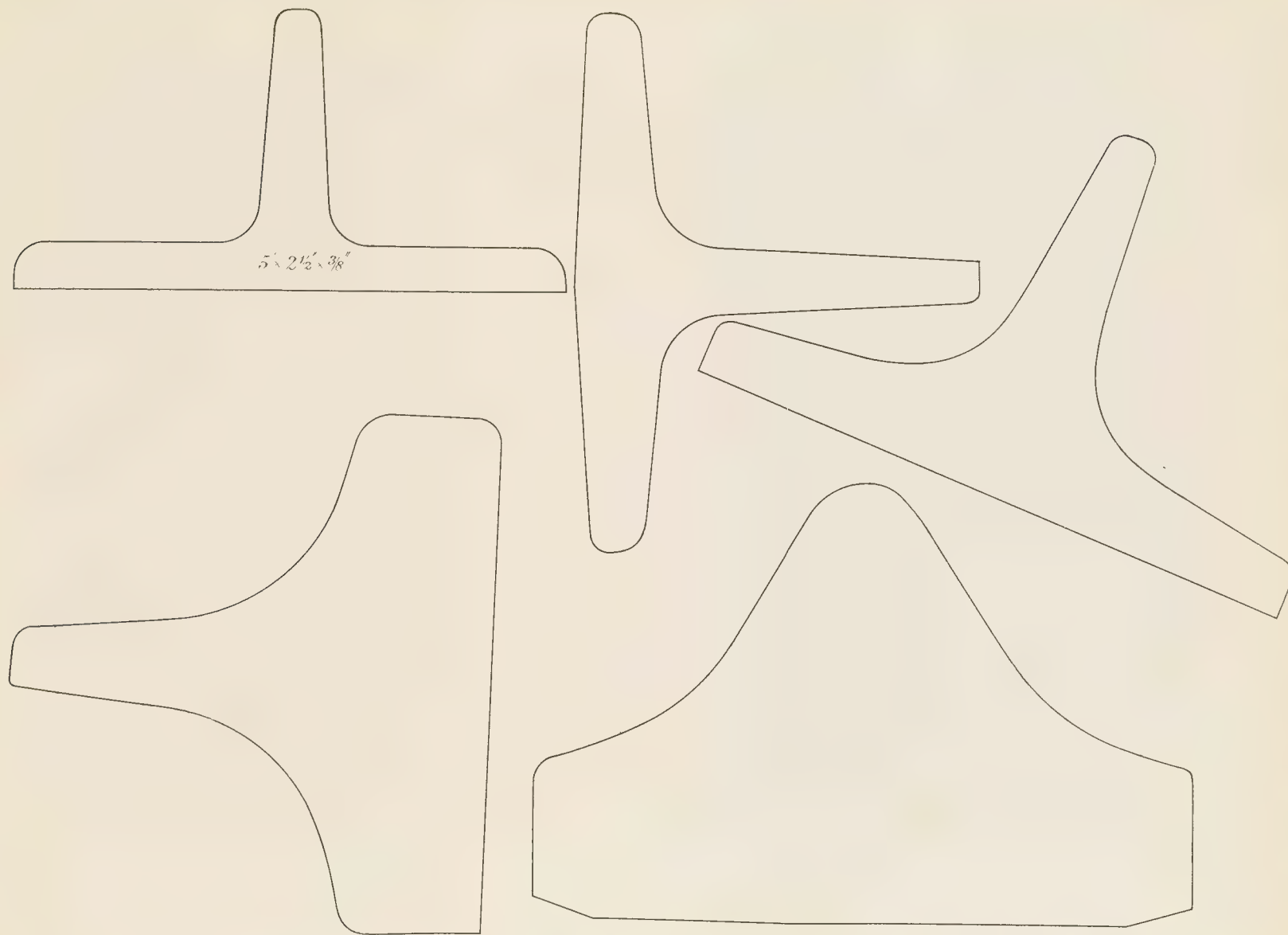


TOP ROLL THREE FIRST GROVES 5" x 3" ANGLES.



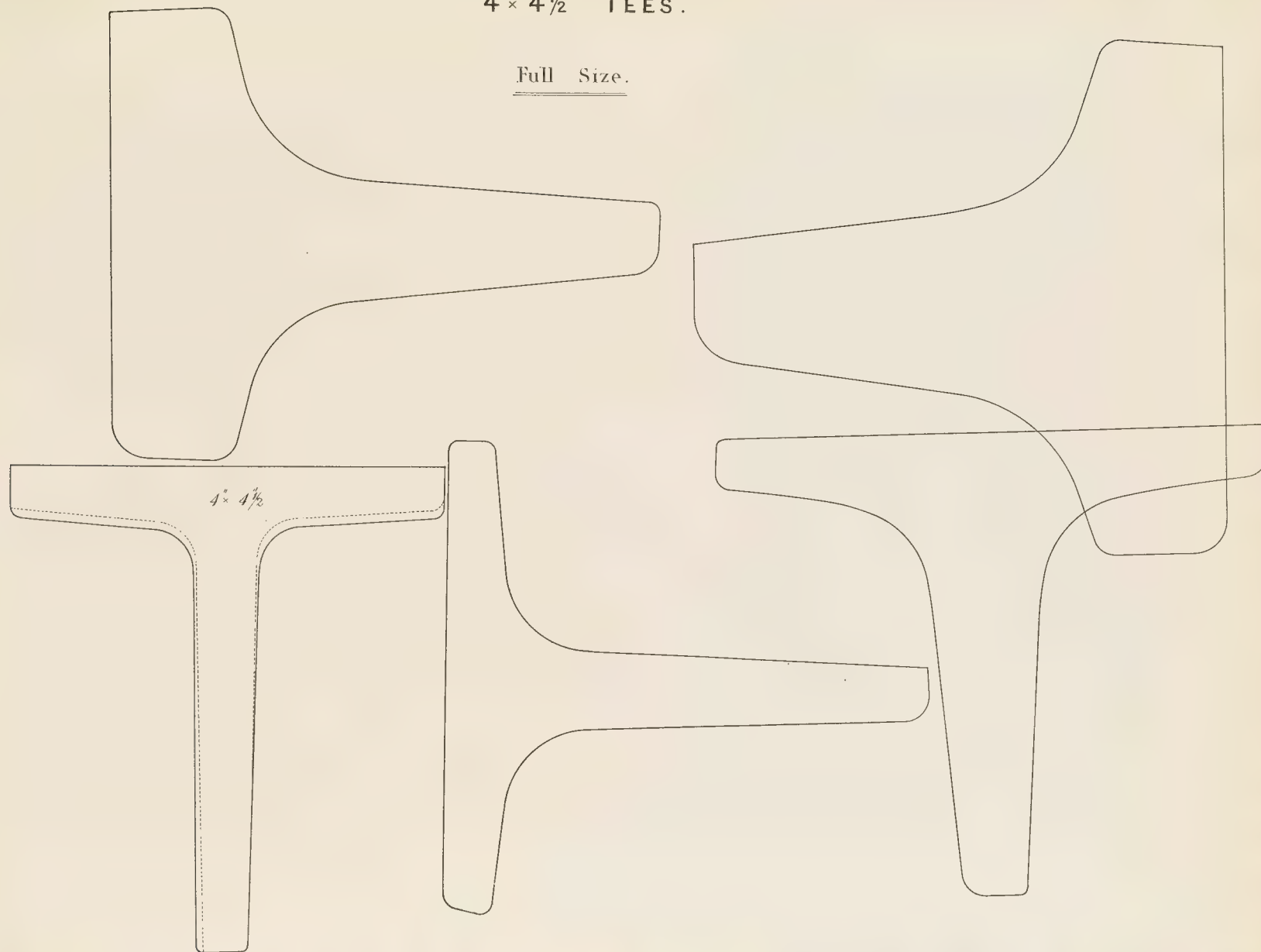
$5'' \times 2\frac{1}{2}''$ ANGLES. Full Size.

Plate XLIX



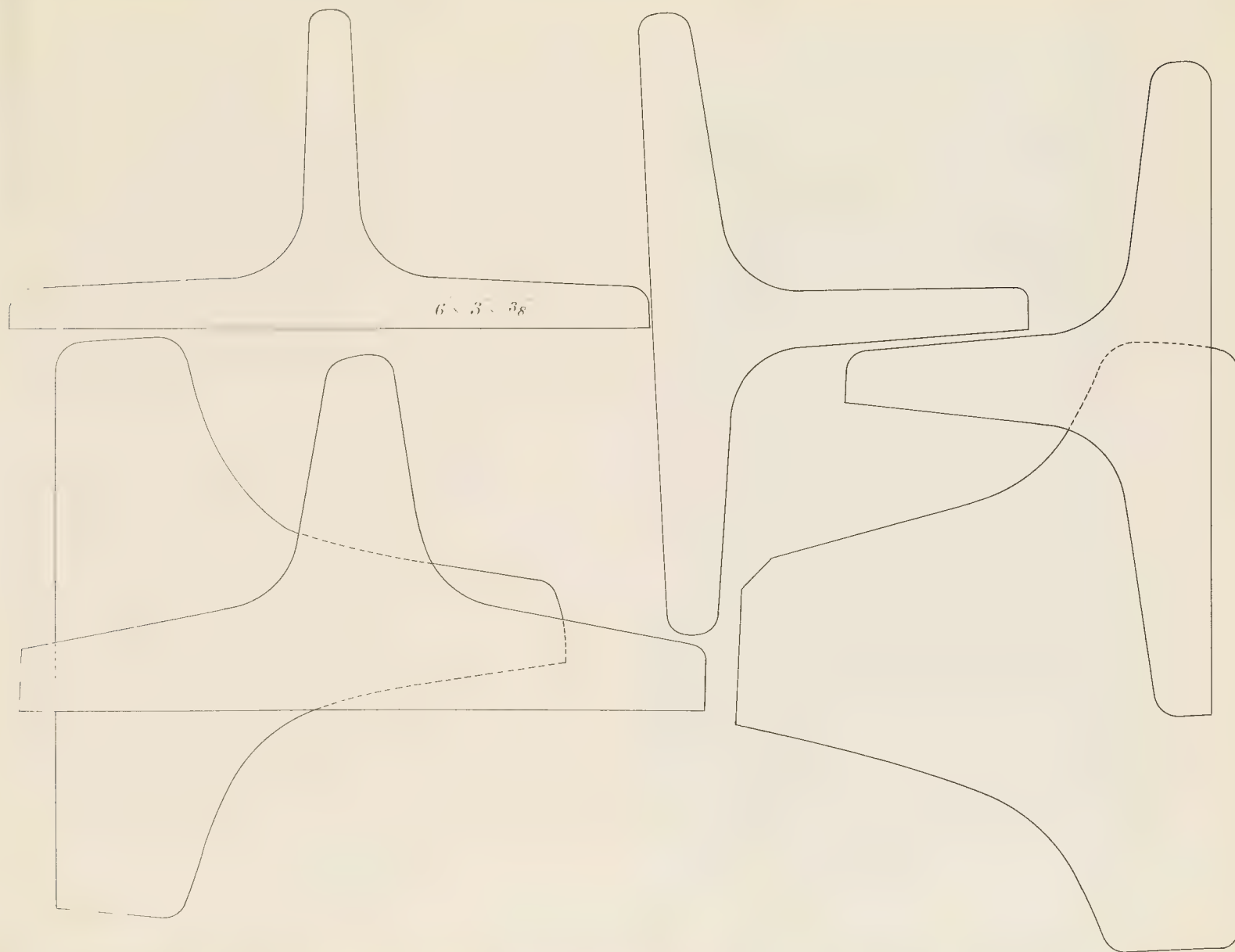
$4'' \times 4\frac{1}{2}''$ TEES.

Full Size.



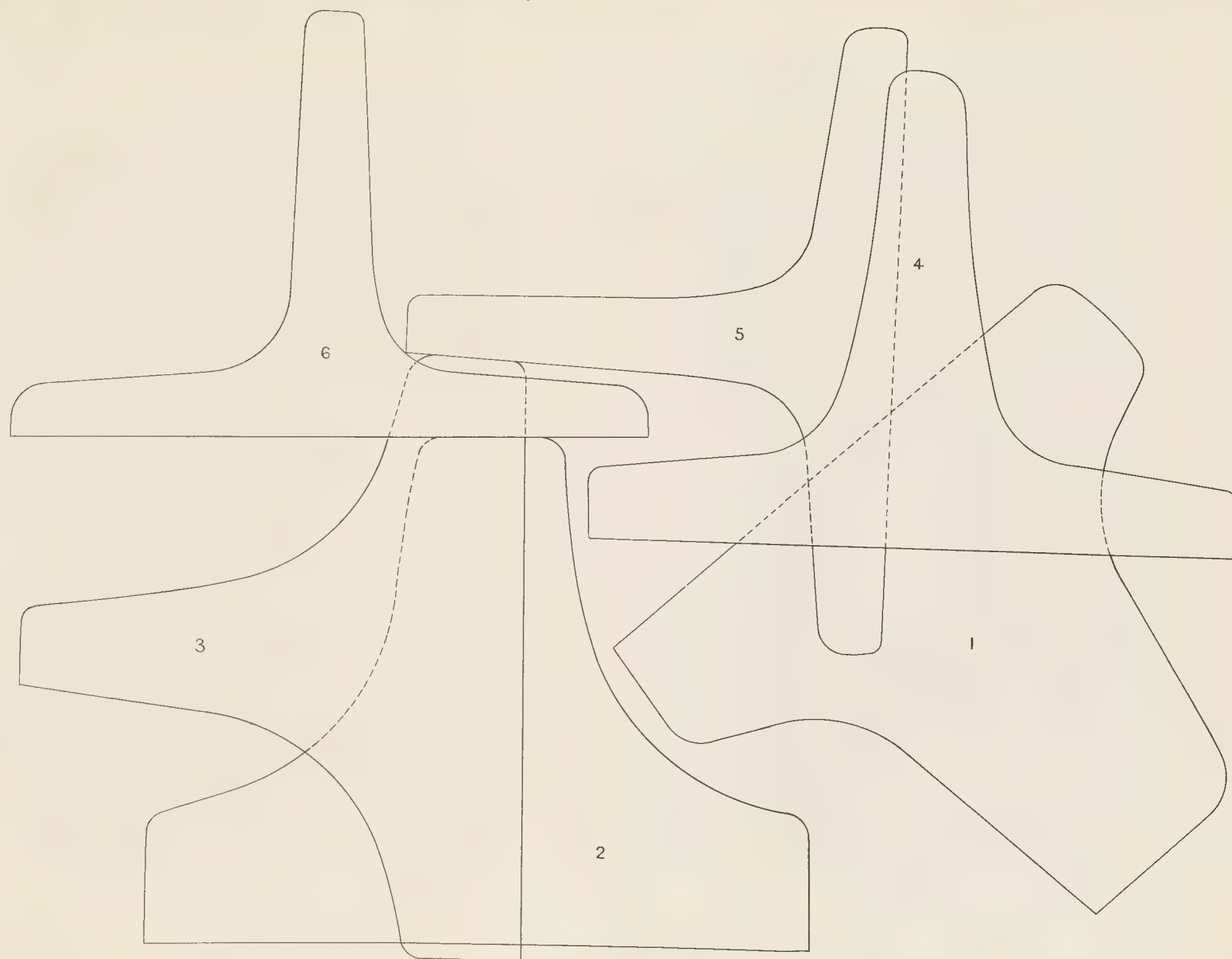
$6 \times 3 \times \frac{3}{8}$ TEES. FULL SIZE.

Plate LI.



6' x 4" TEES. FULL SIZE.

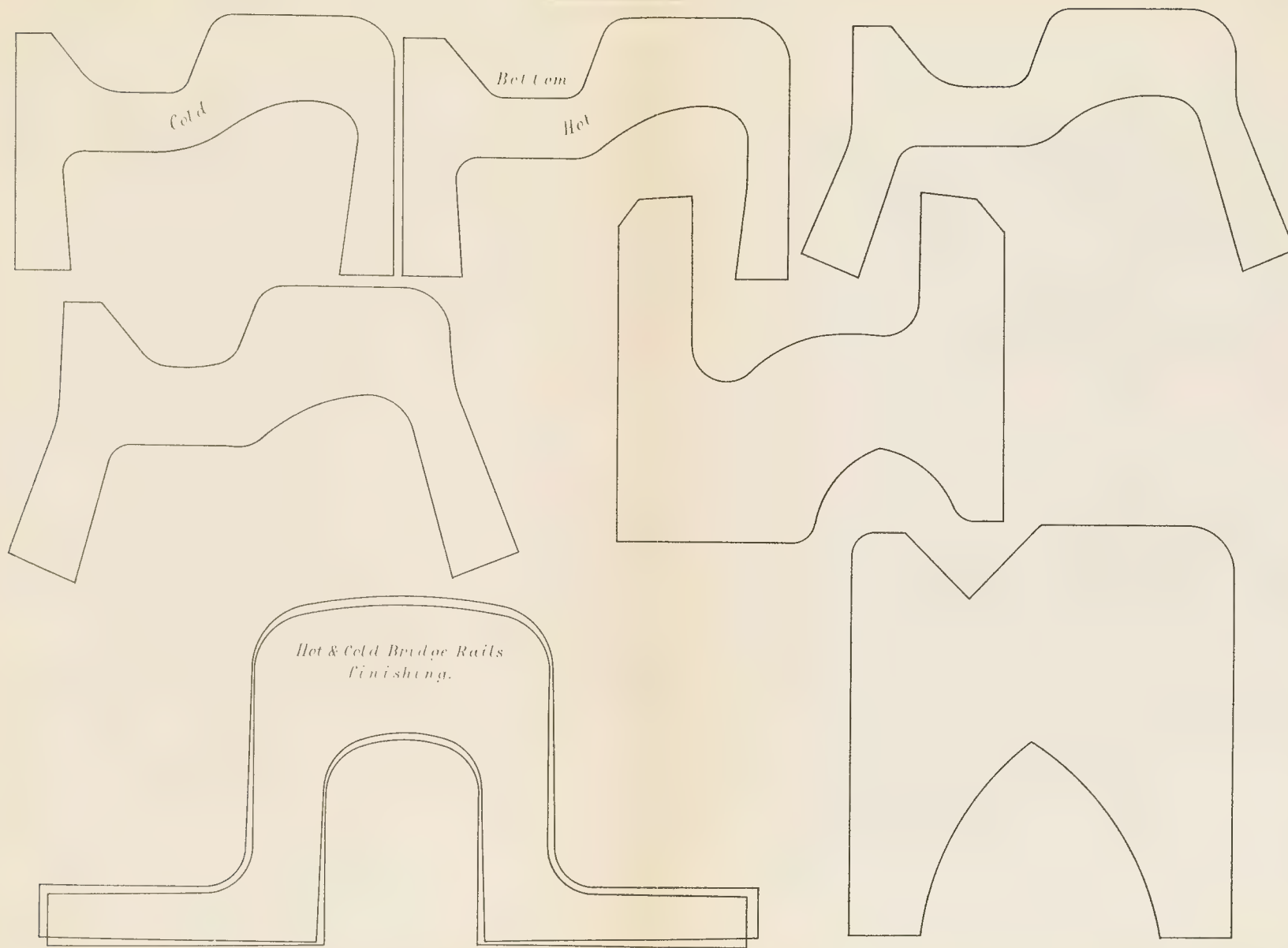
Plate LII

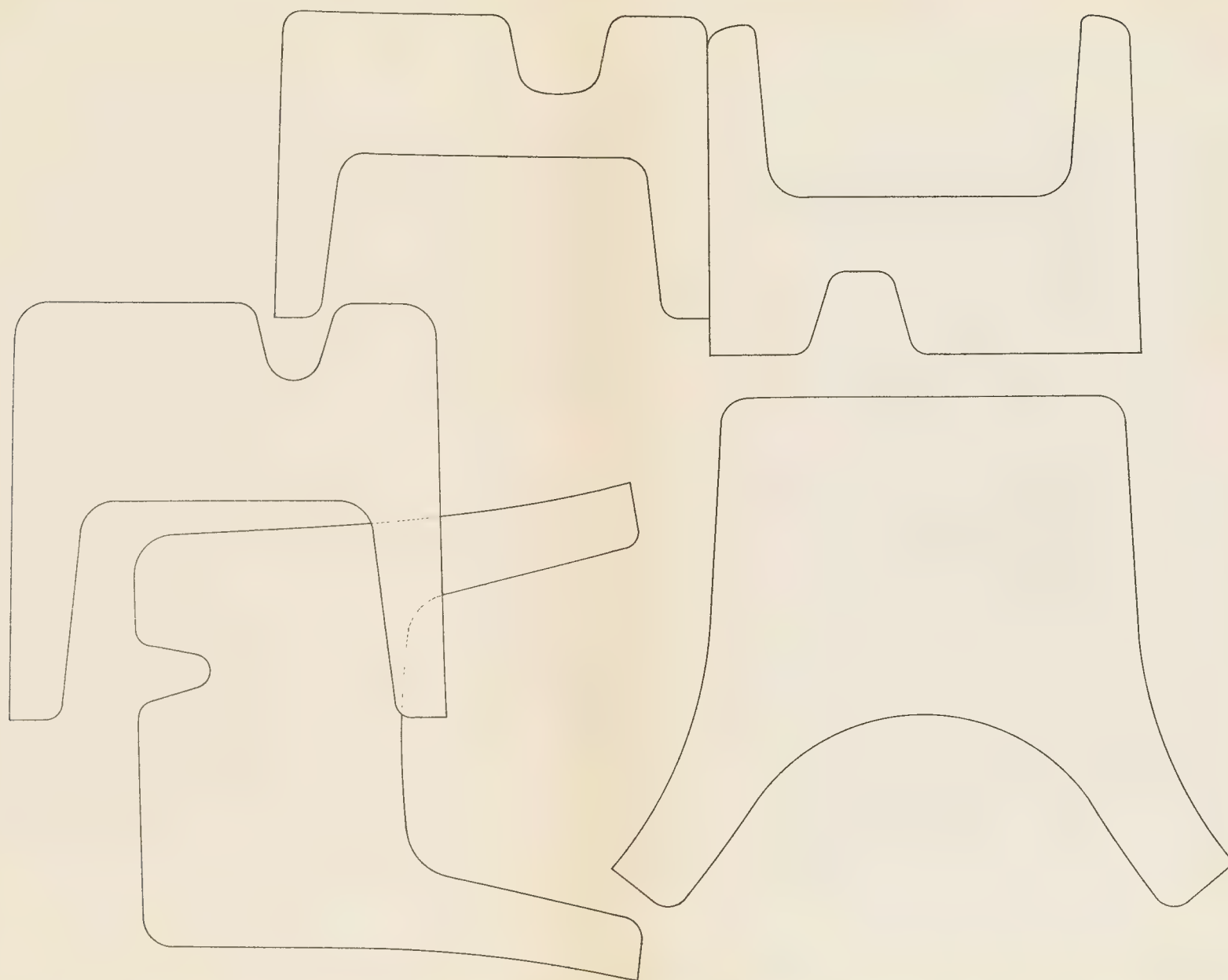


STEEL TRAM RAILS.

Full Size.

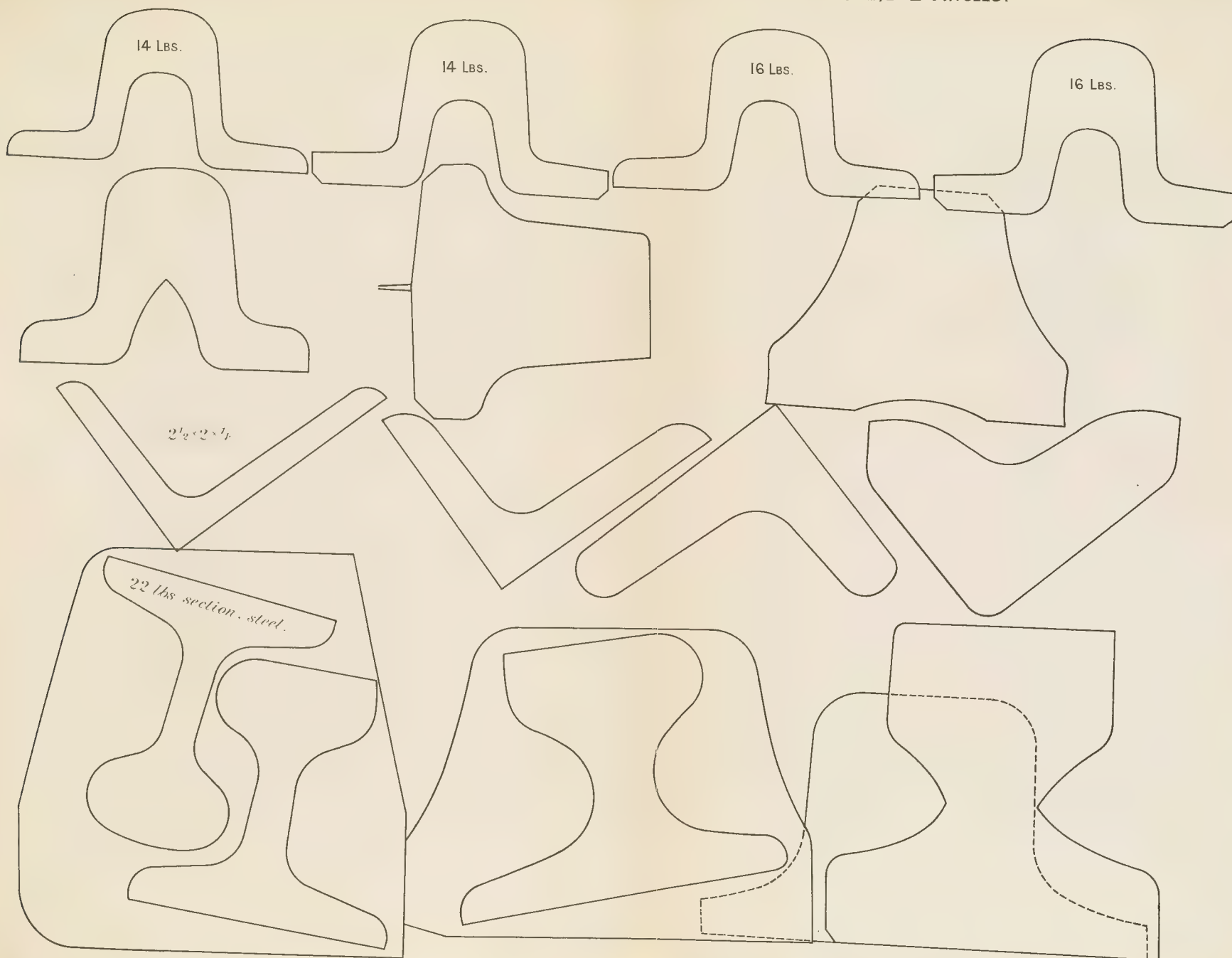
Plate LIII.





14 LBS PR YD BRIDGE RAILS, 22 LBS PR YD FLANGE RAILS. & $2\frac{1}{2} \times 2'$ ANGLES.

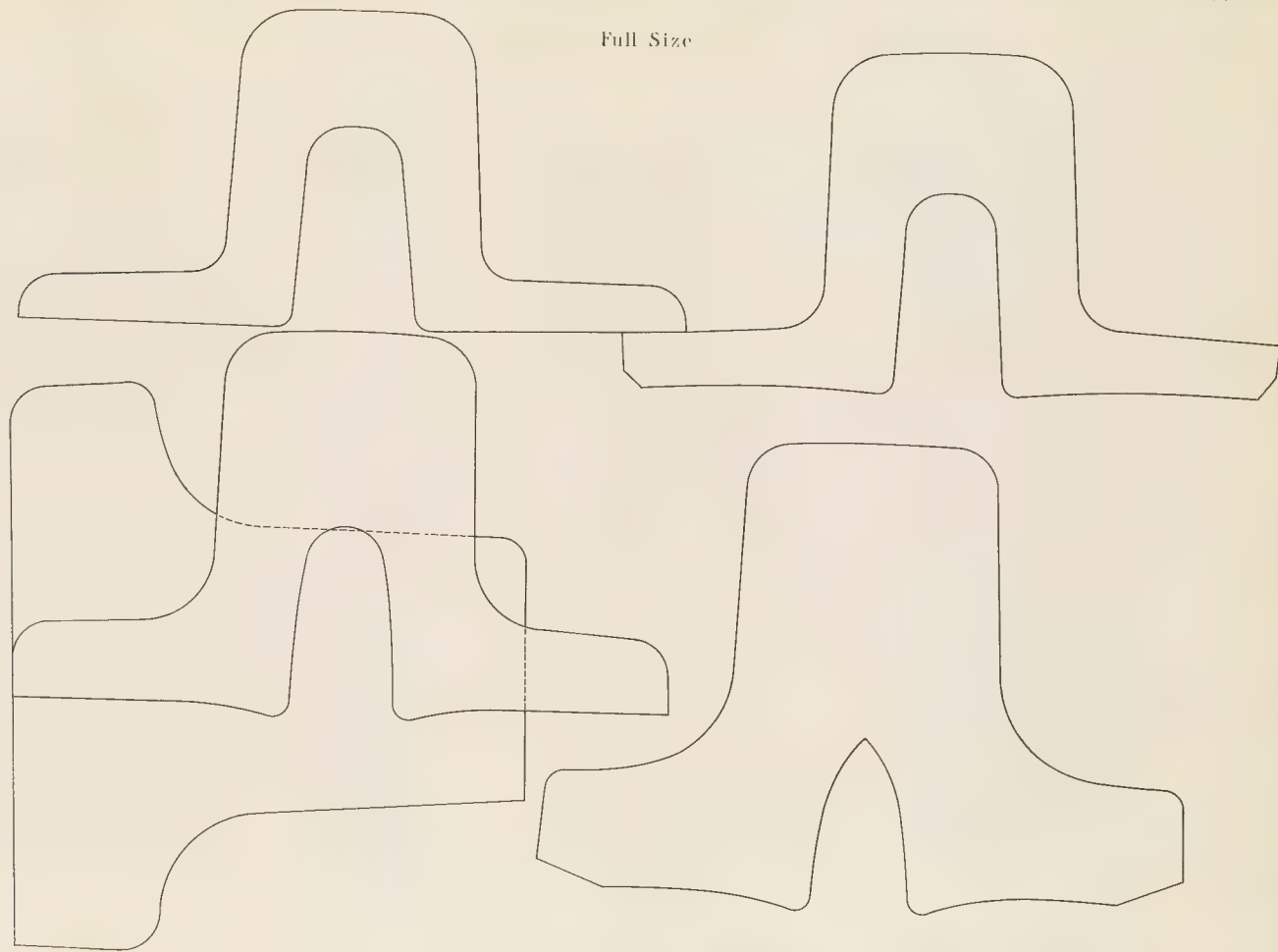
Plate IV



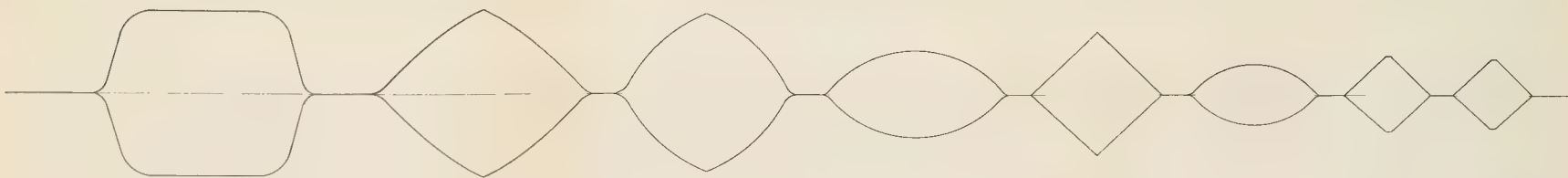
BRIDGE RAIL.

Plate IV.

Full Size



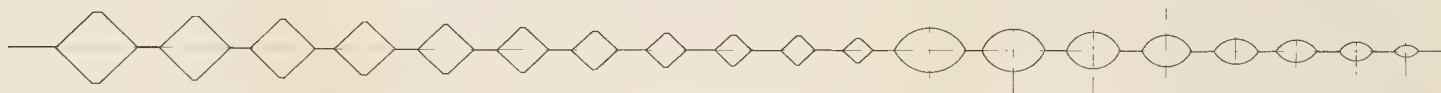
1ST ROUGHING: 3 HIGH, FOR 8" GUIDE MILL—GROOVES FULL SIZE.



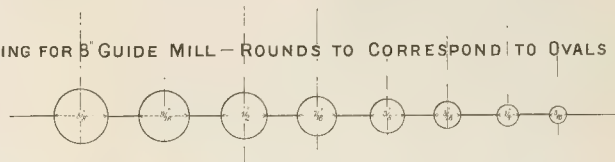
COMPLETION OF 1ST ROUGHING FOR 8" GUIDE MILL—GROOVES FULL SIZE



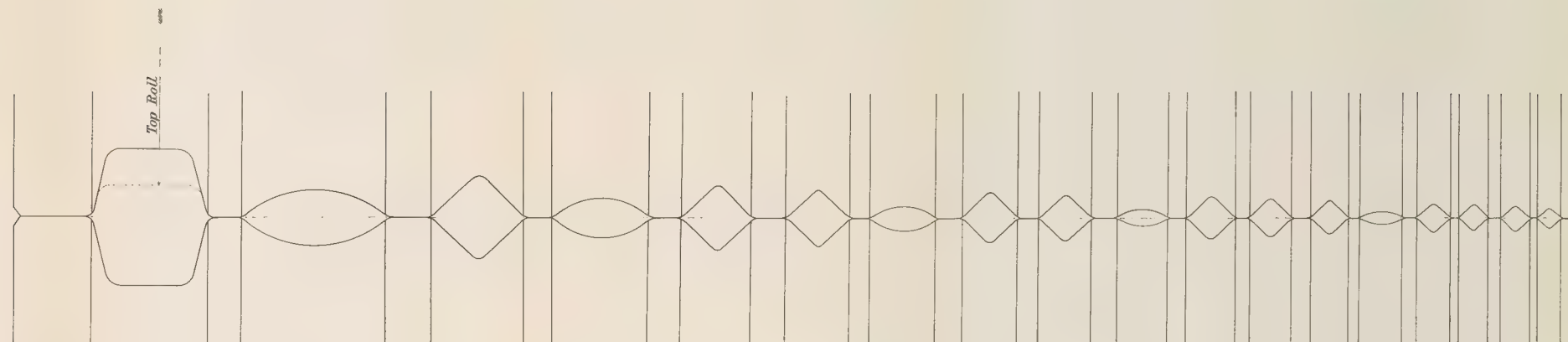
2ND ROUGHING: 3 HIGH—DIAMONDS & OVALS FOR 8" GUIDE MILL.



FINISHING FOR 8" GUIDE MILL—ROUNDS TO CORRESPOND TO OVALS ABOVE.



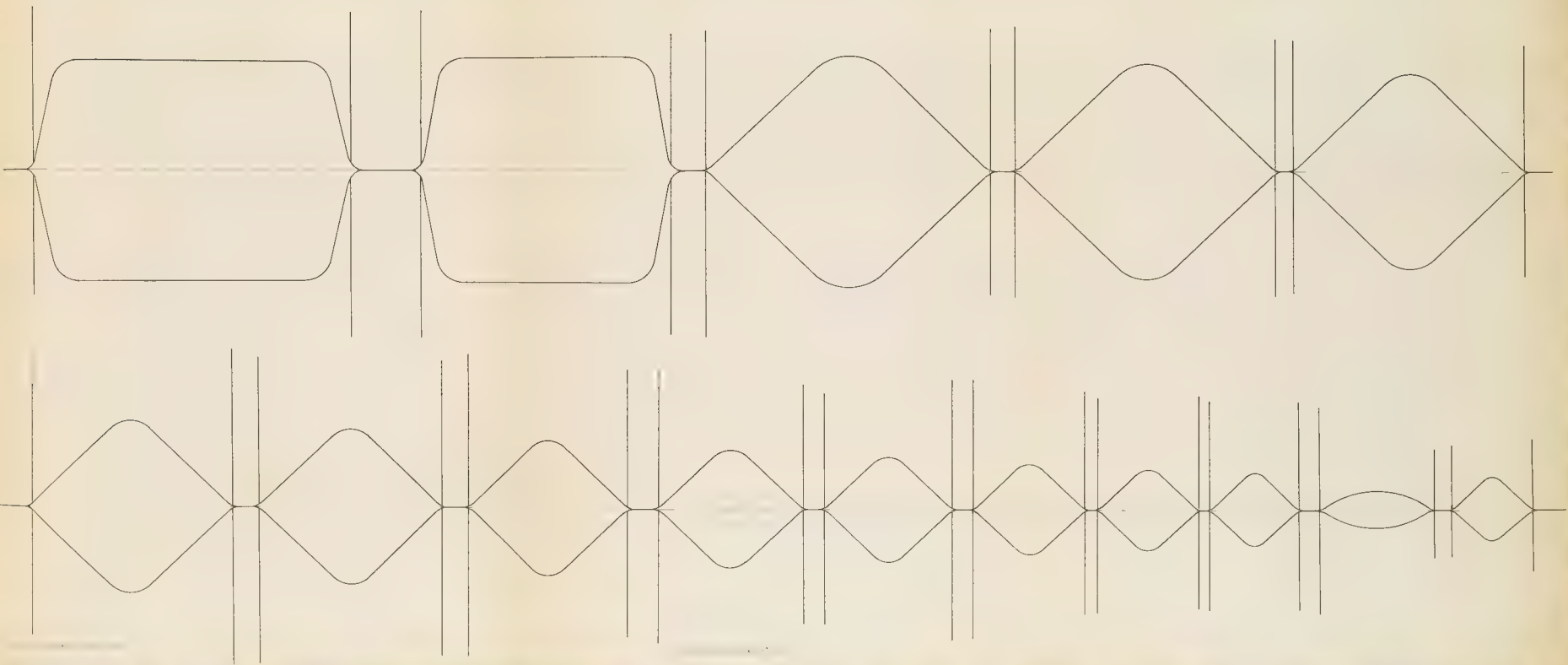
THREE-HIGH ROUGHING FOR 8" GUIDE MILL (2ND ILLUSTRATION) GROOVES FULL SIZE.



Top Roll & 3rd Roll 40" Long 3" Center Groove

1. 6 x 20" Dimensions & 10" High

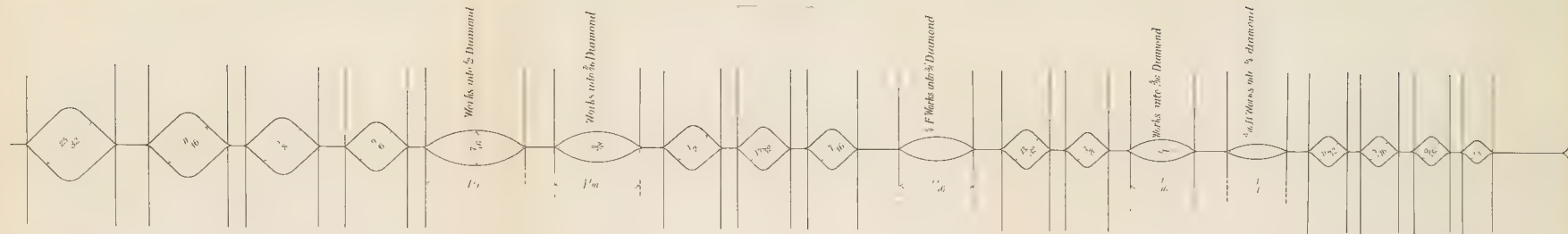
THREE HIGH 1ST ROUGHING FOR 10 GUIDE MILL—GROOVES FULL SIZE



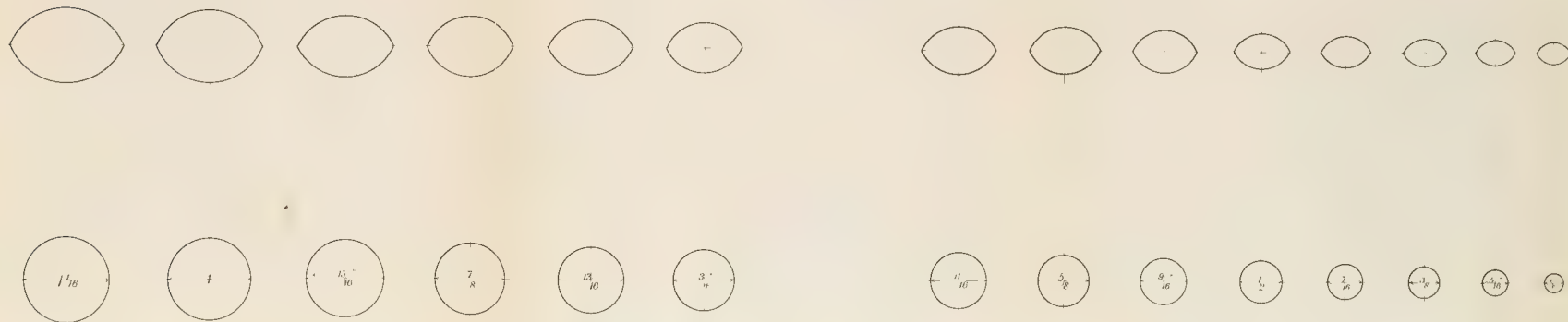
2ND ROUGHING (DIAMONDS & OVALS) FOR 10' GUIDE MILL

Plate LX

Grooves full Size.

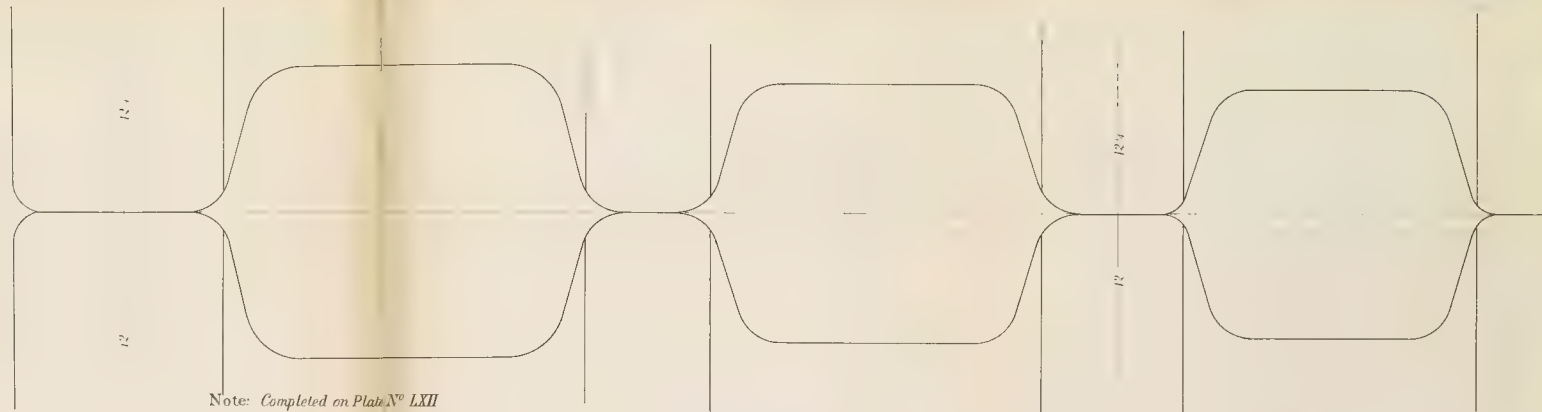


FINISHING OVALS & ROUNDS FOR 10' GUIDE MILL ROLLS IN BOTH CASES 10' LONG OVALS TO CORRESPOND TO ROUNDS DRAWN BELOW

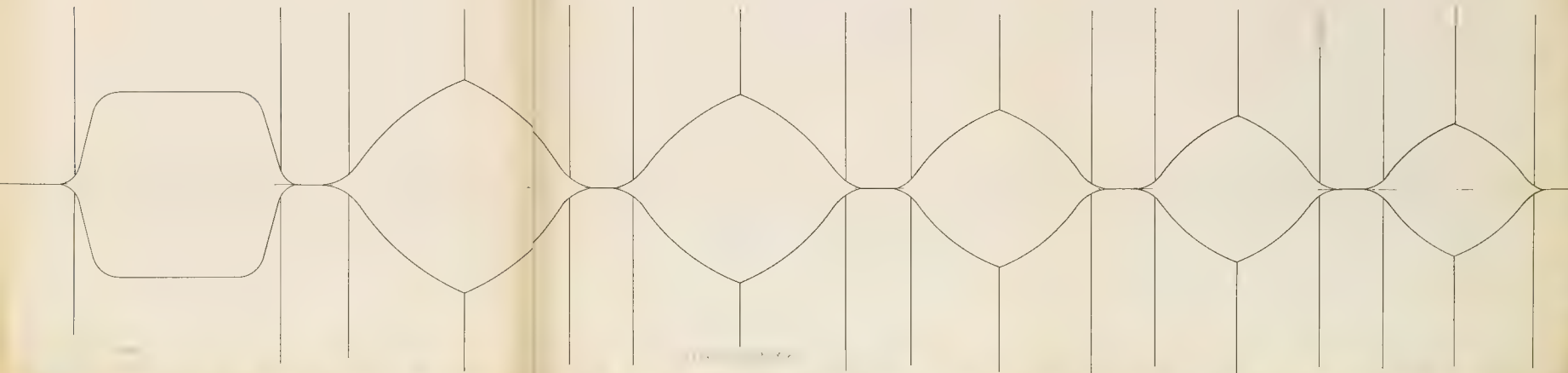


THREE-HIGH ROUGHING FOR 12' BAR MILL.—GROOVES FULL SIZE.

Plate LXI

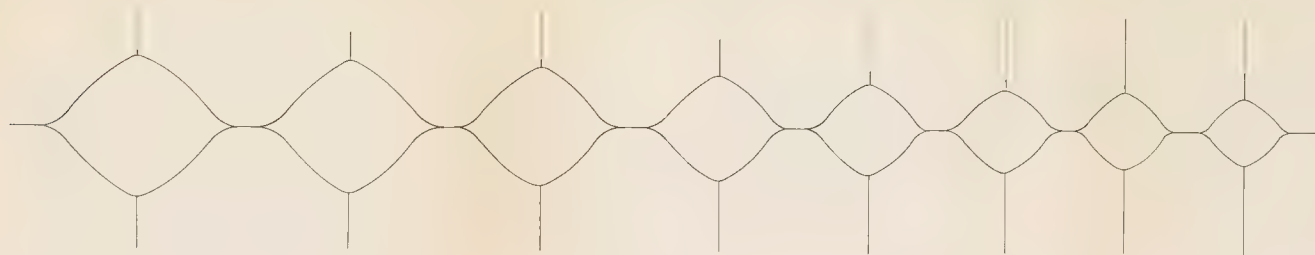


Note: Completed on Plate N° LXII

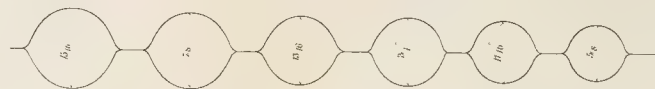
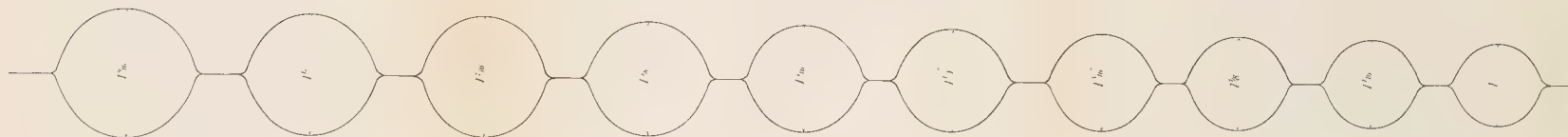


THREE-HIGH ROUGHING FOR 12" BAR MILL-GROOVES FULL SIZE, COMPLETED, SEE PLATE N° LXI.

Plate LXII



FINISHING FOR 12" BAR MILL-ROUNDS $1\frac{3}{16}$ TO $\frac{5}{8}$ " FULL SIZE.

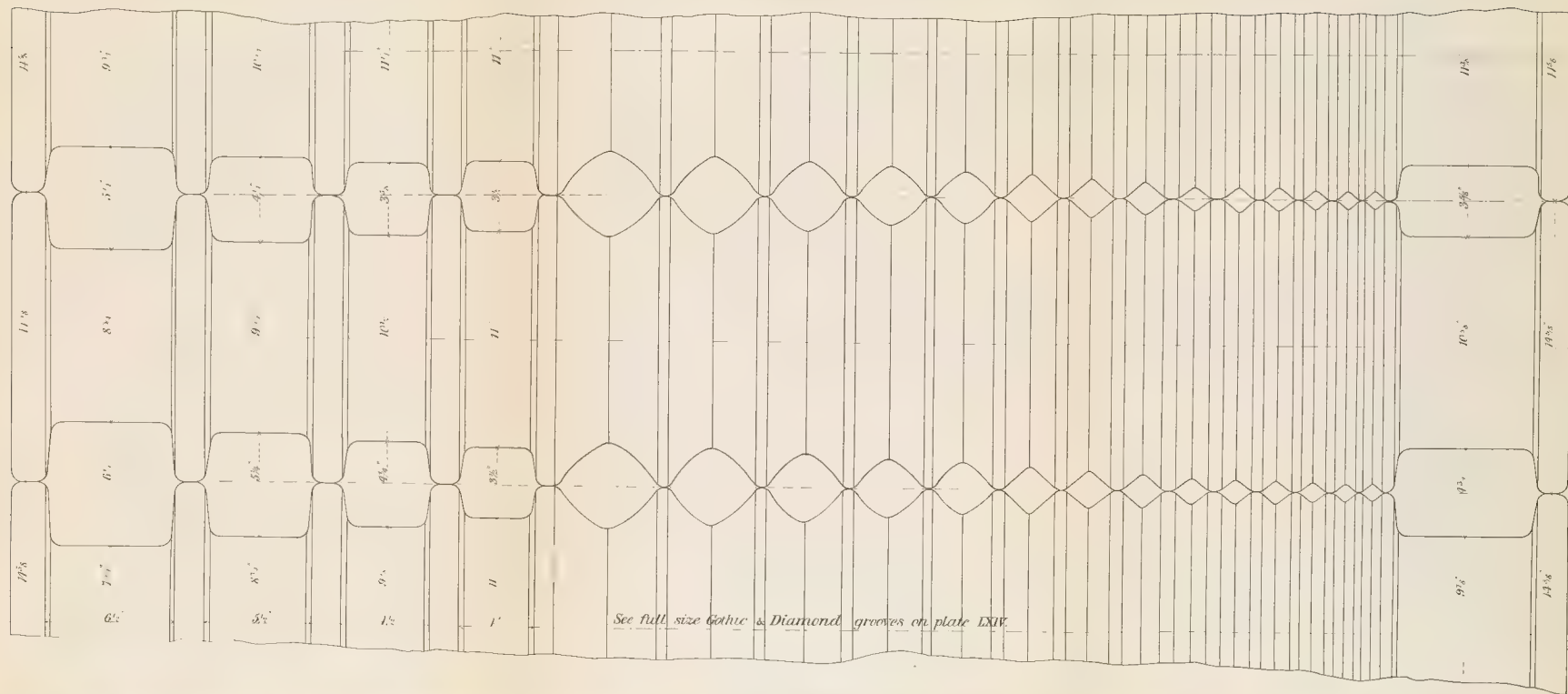


THREEHIGH ROUGHING FOR 14" BAR (AND GUIDE) MILL.

Note: 6 6' long Neck 7½' diam 8' long. Wabblers 7' long.

Scale 3-1 Foot.

Plate LXIII

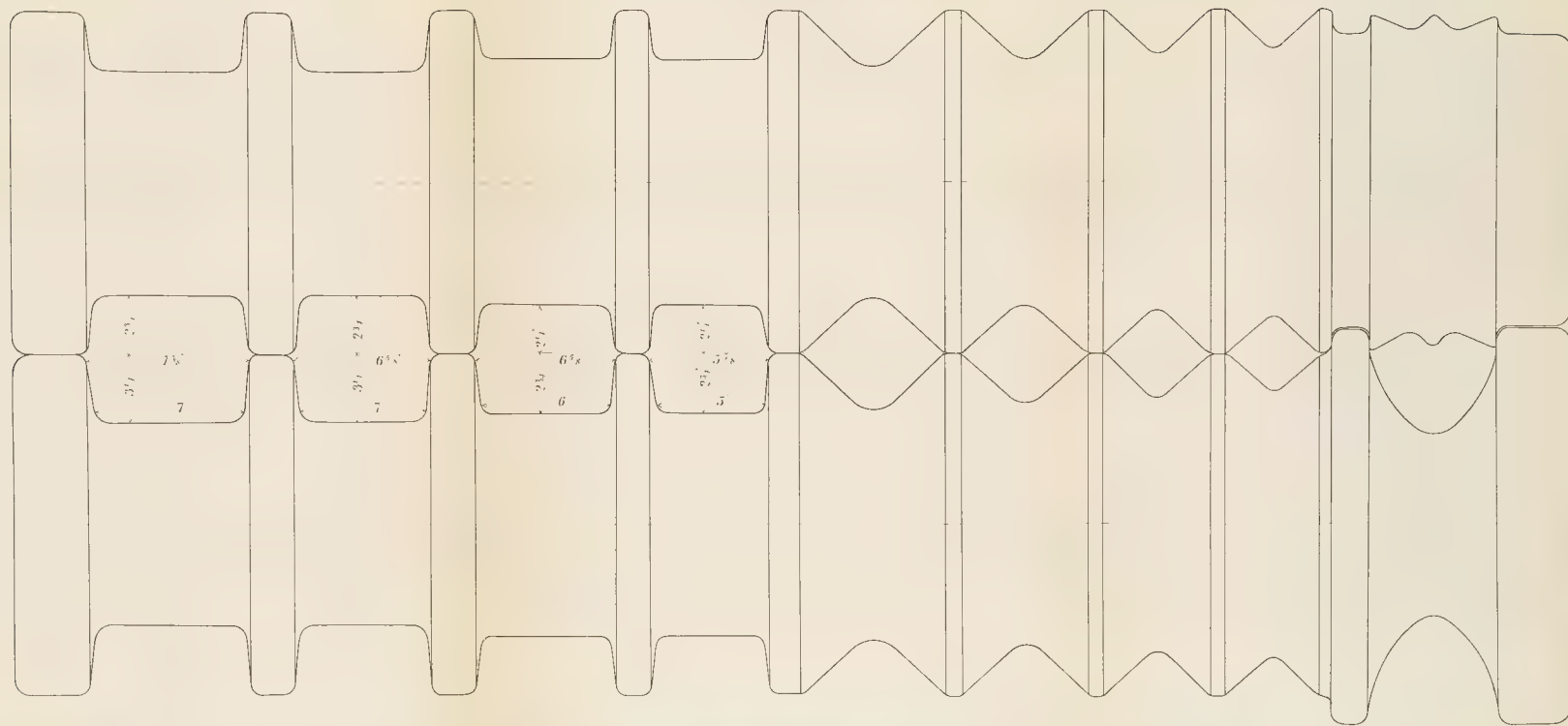


GOthic & DIAMOND GROOVES FOR 14" BAR [& GUIDE MILL].

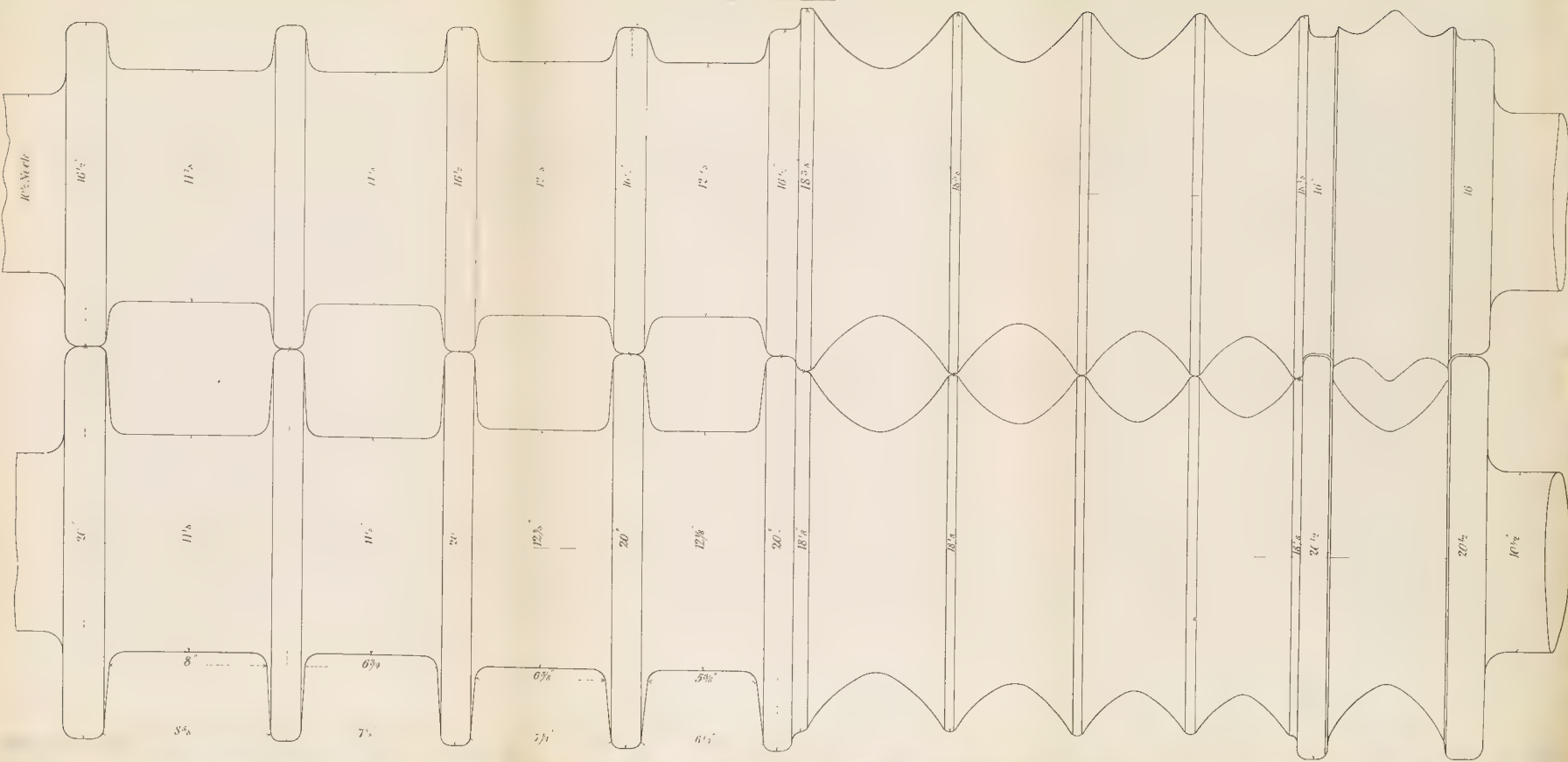
1 1/2

Full Size . See Plate N° 63



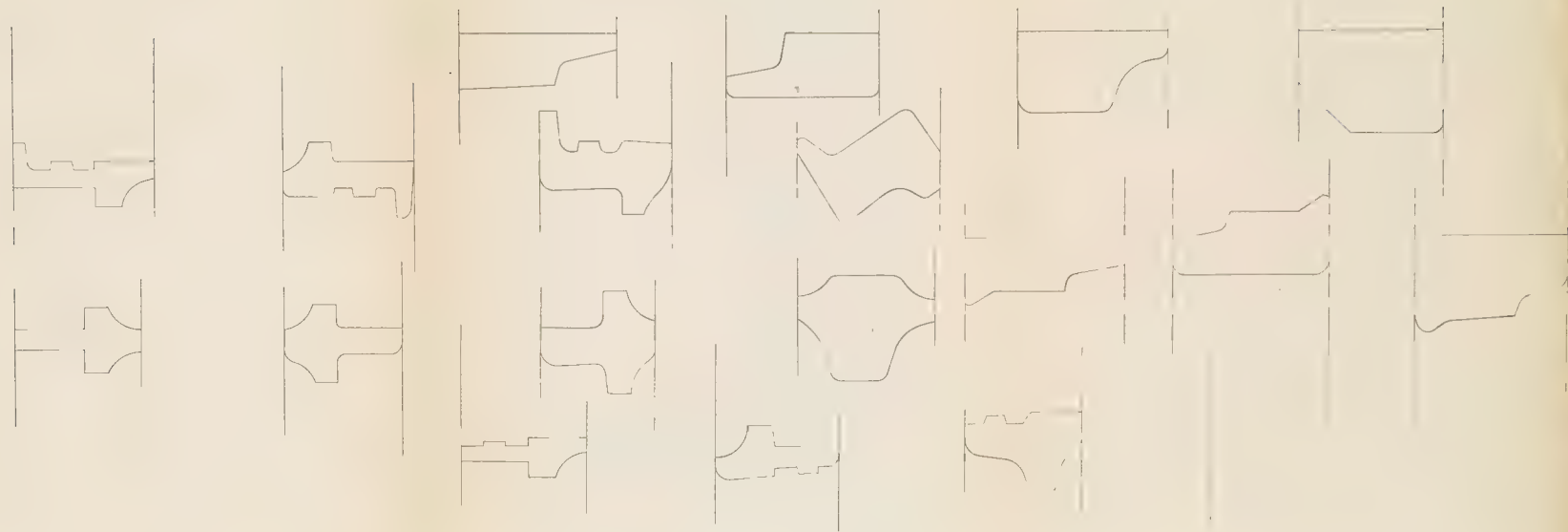


Scale 3 - 1 Foot



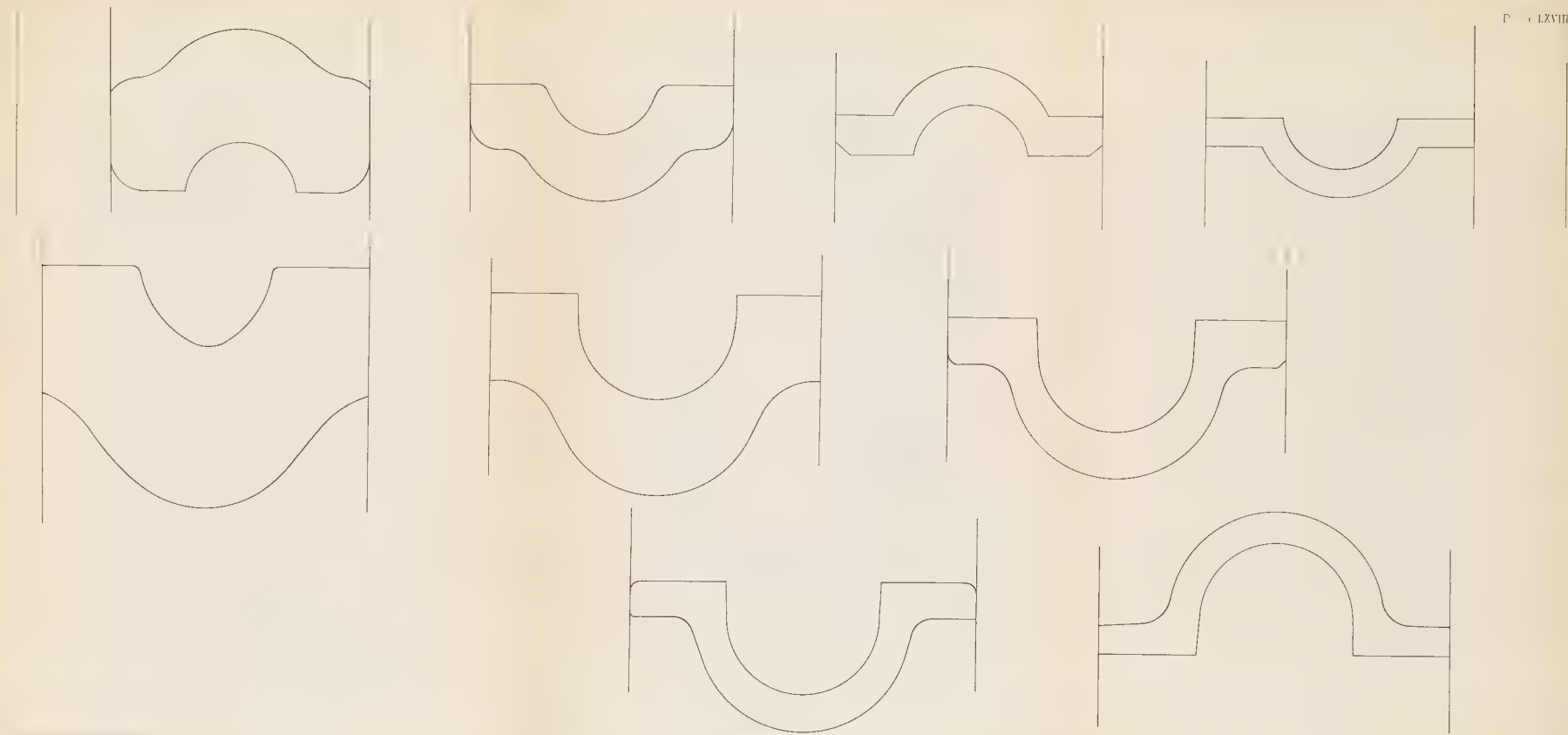
SASH BARS (5 SETS) FULL SIZE

Plate LXVII



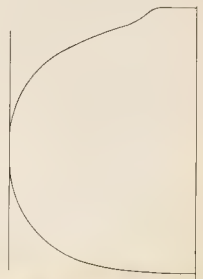
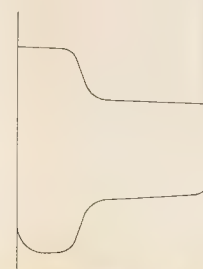
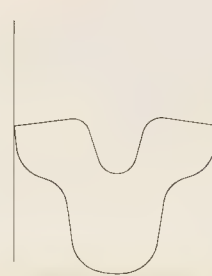
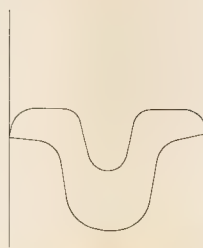
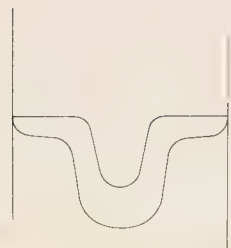
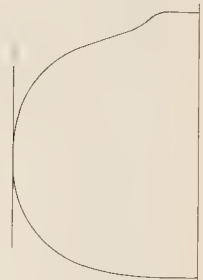
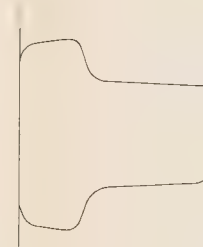
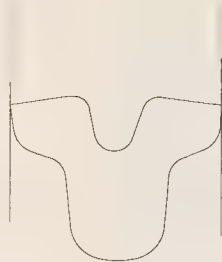
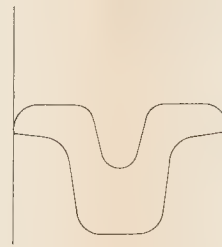
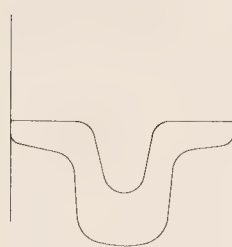
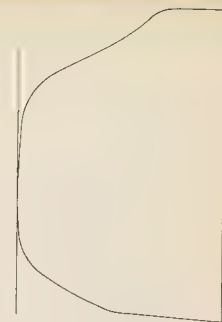
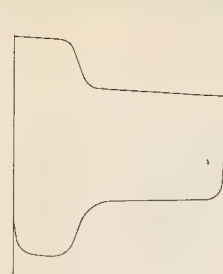
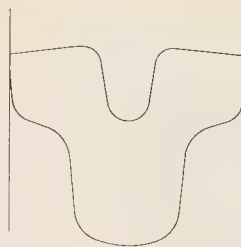
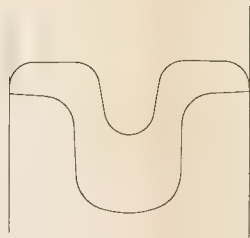
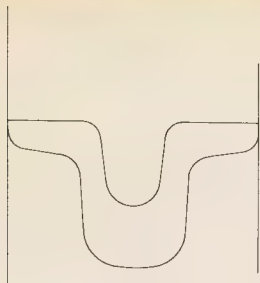
SADDLES 2 SETS FULL SIZE.

P. LXVIII



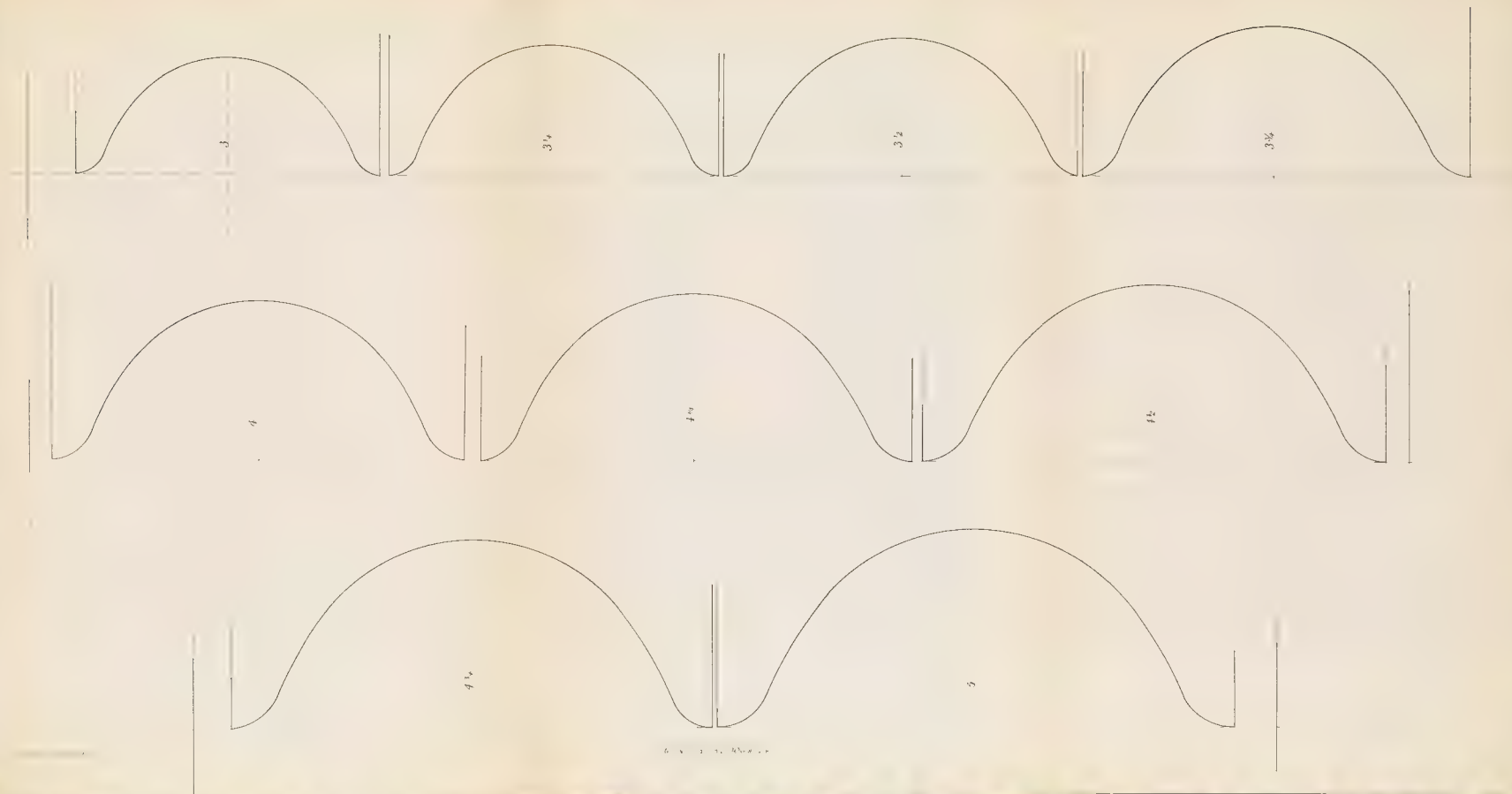
BRIDGE RAILS 3 SETS FULL SIZE.

Page LIX



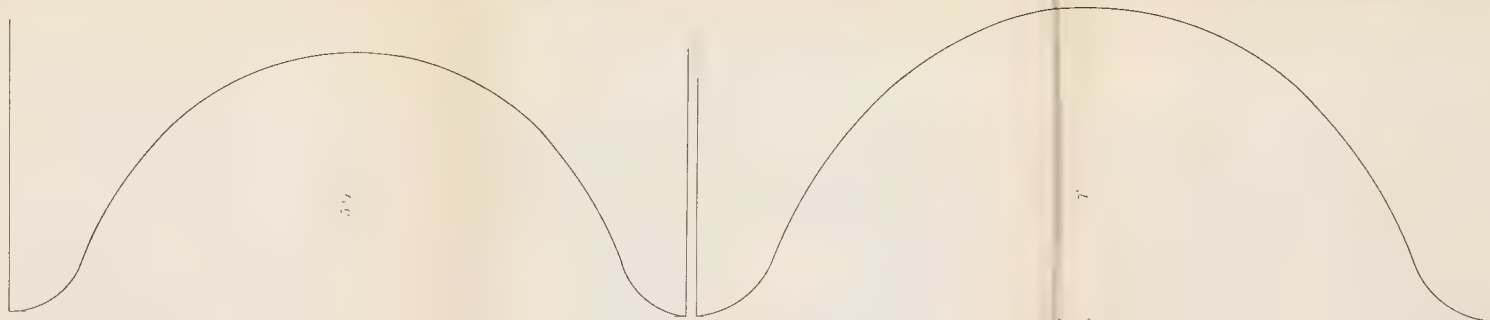
FINISHING. ROUNDS 3^d TO 5th FULL SIZE.

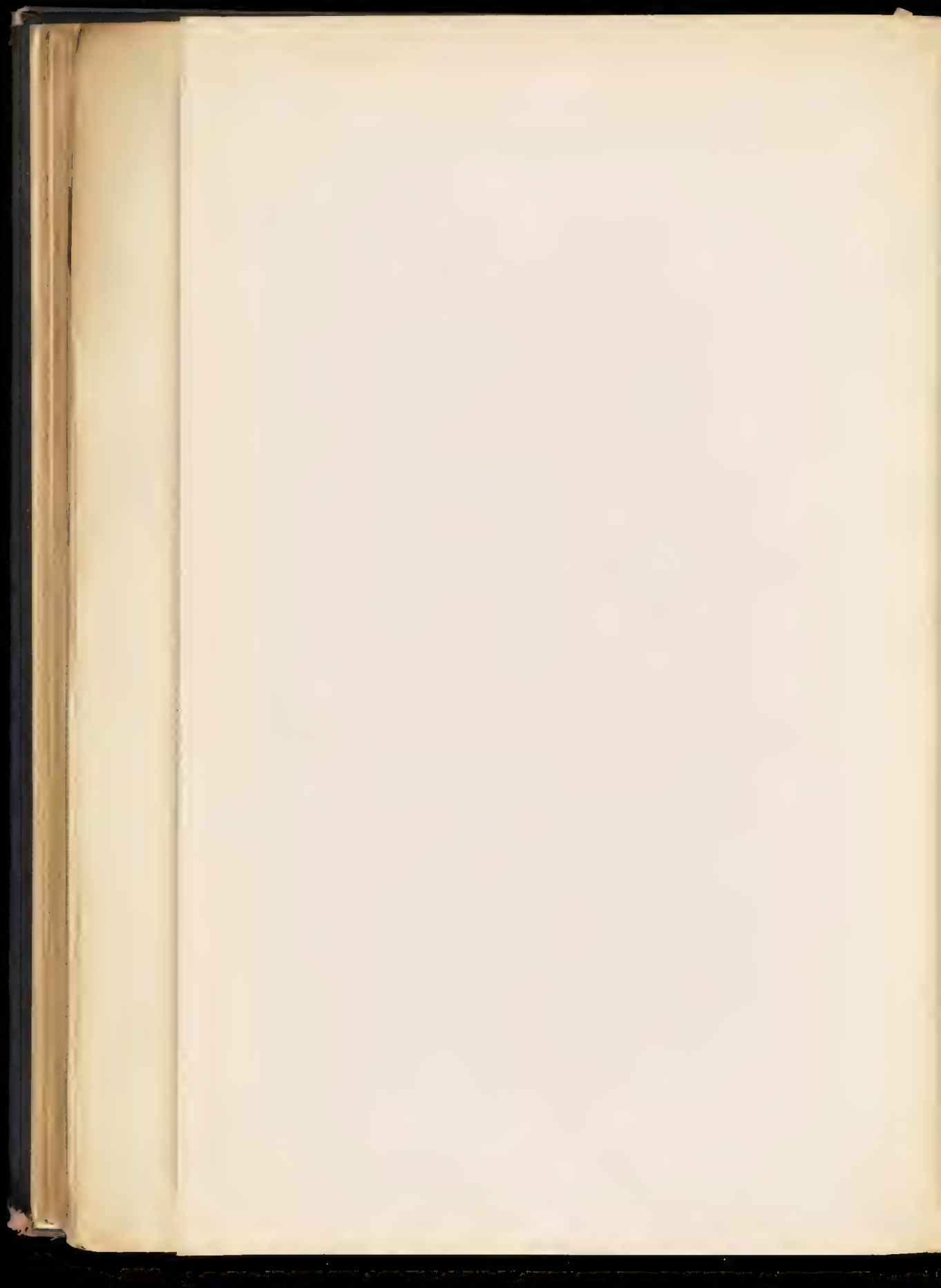
Plate LXX



FINISHING ROUNDS $5\frac{1}{2}$, 7 , & $8\frac{1}{2}$.

Plate LXXI

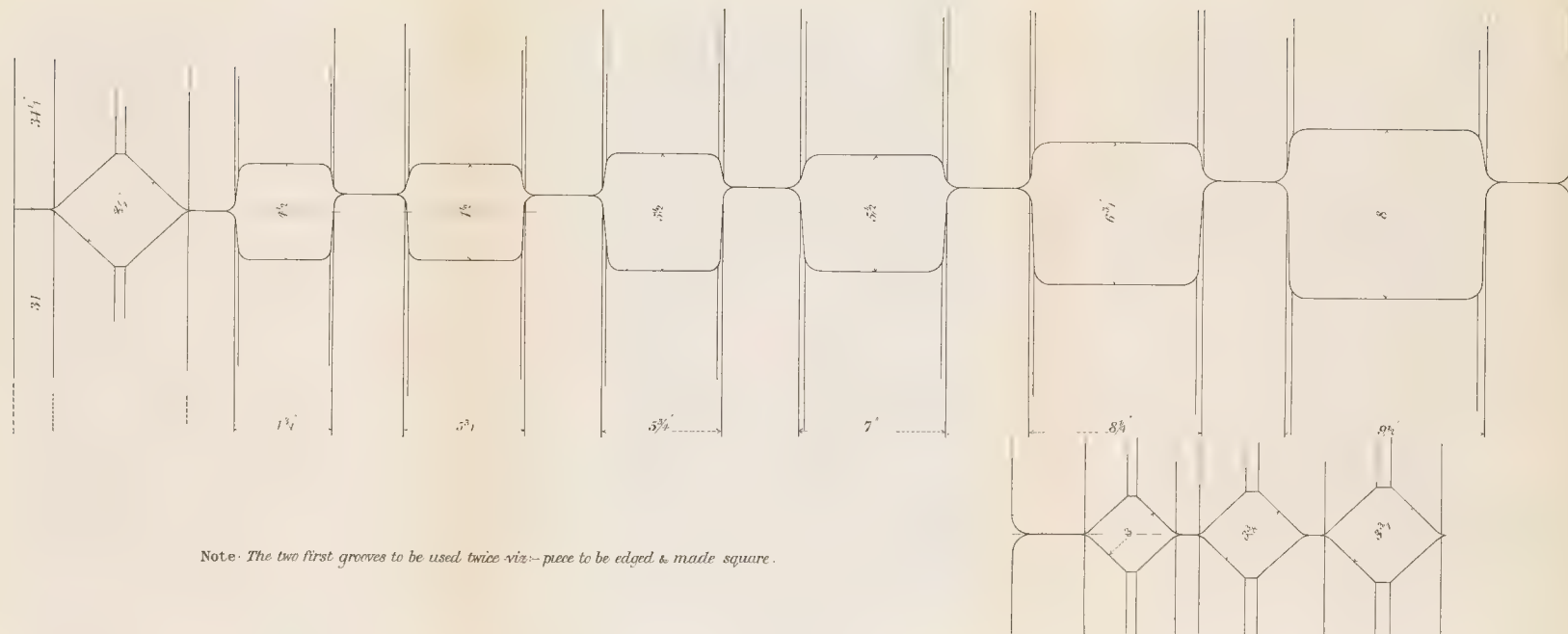


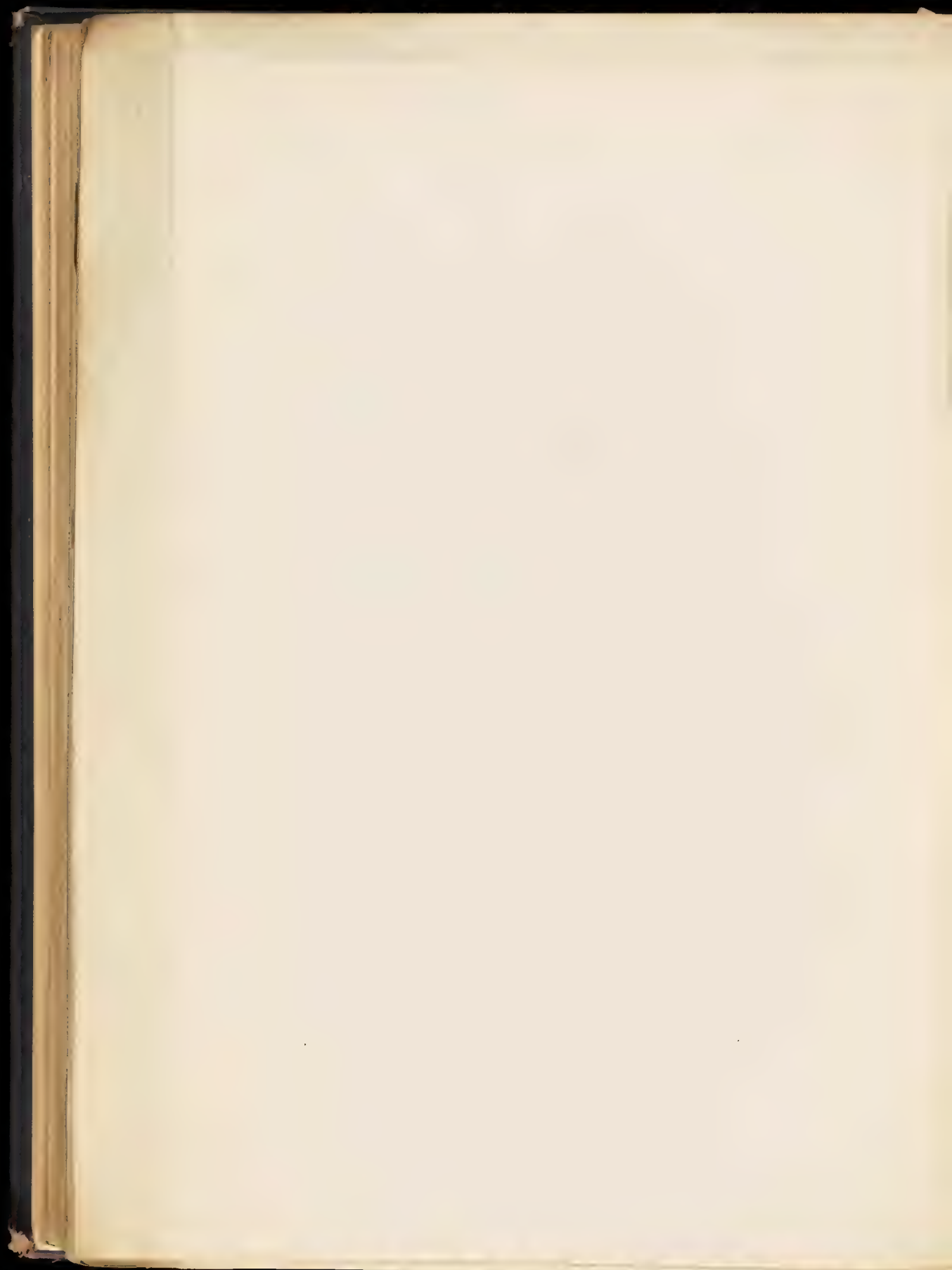


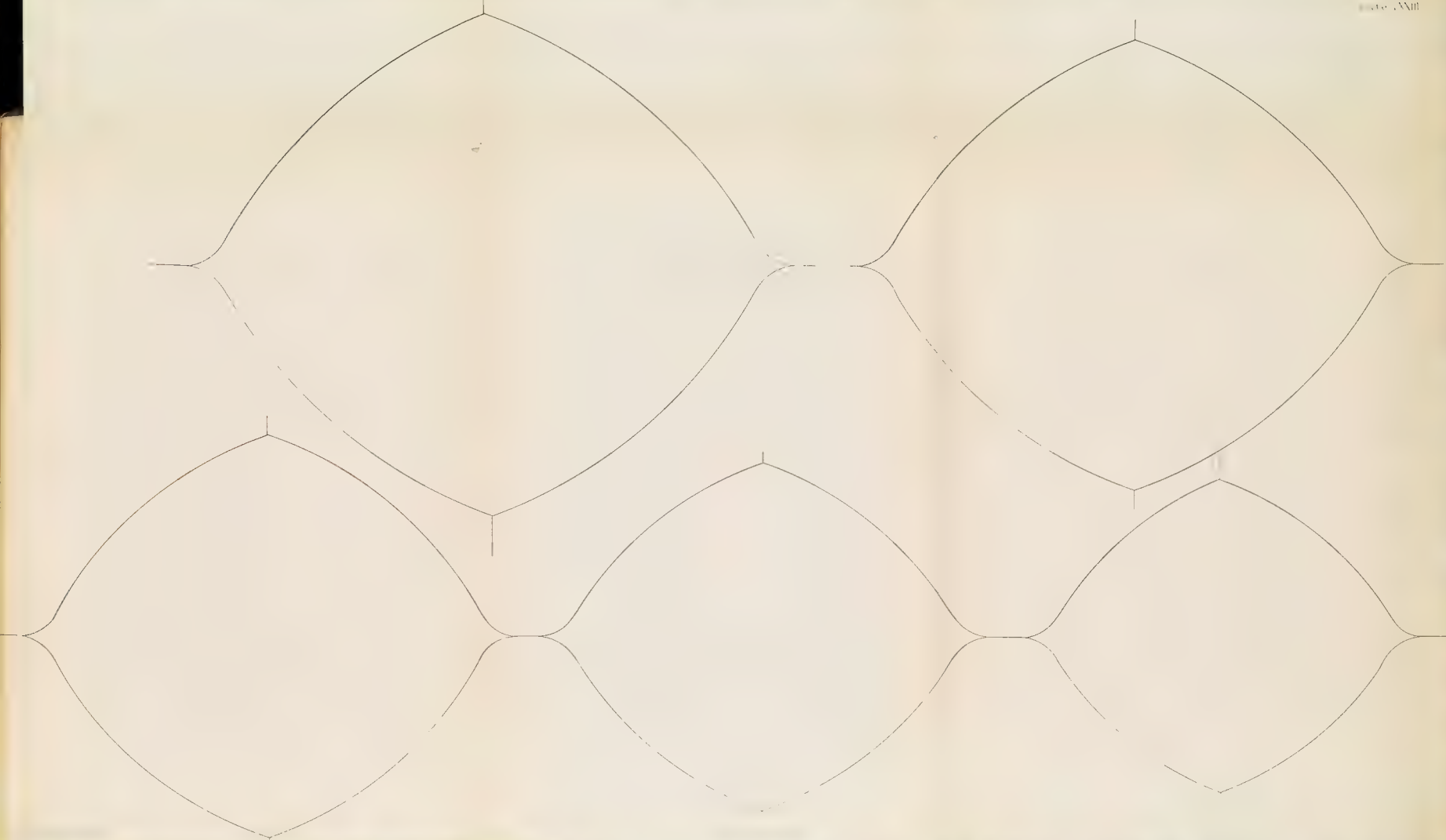
BLOOMING FOR BILLETS FROM STEEL INGOTS.

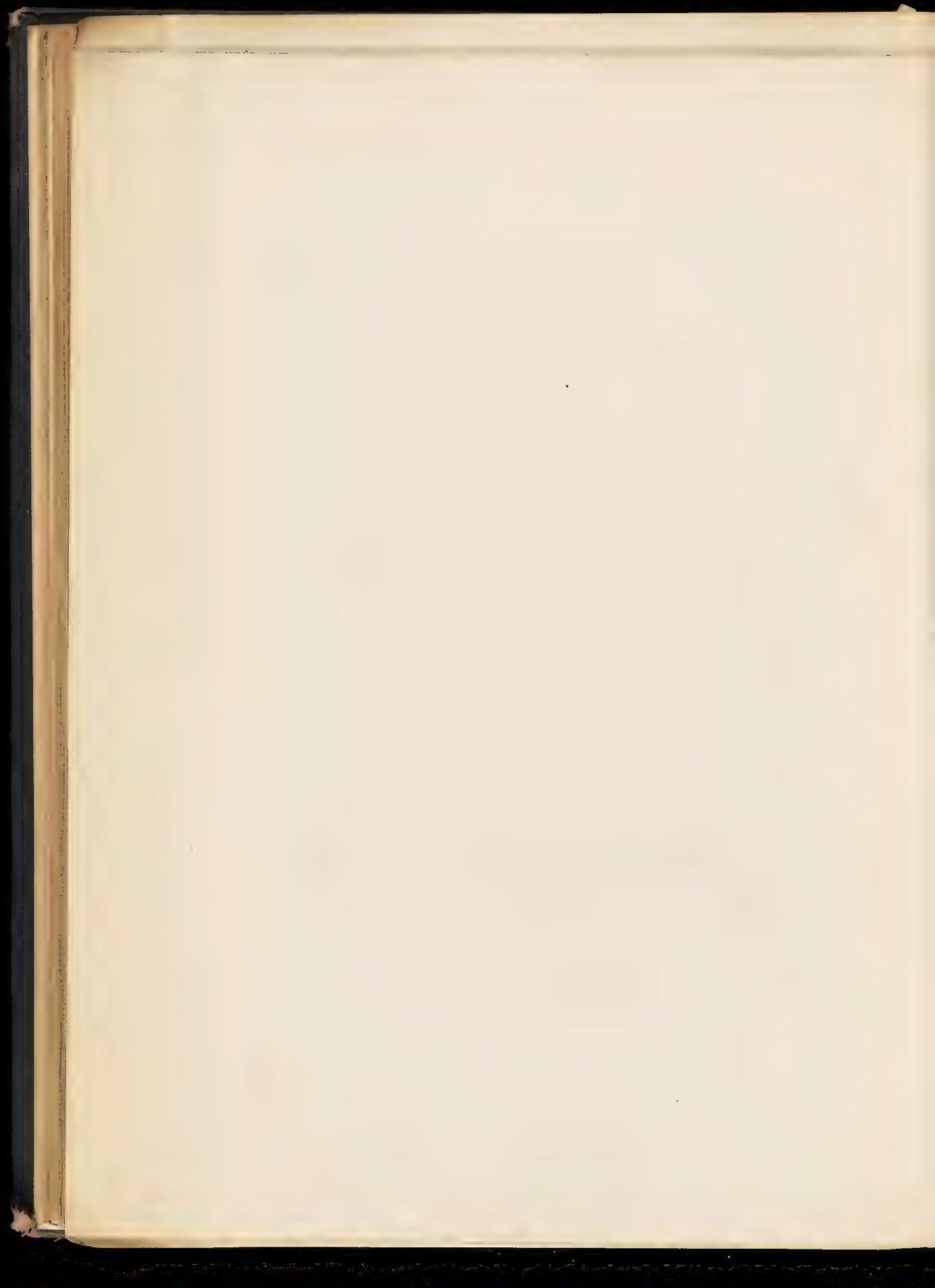
Plate LXXII

Scale 3 = 1 Foot







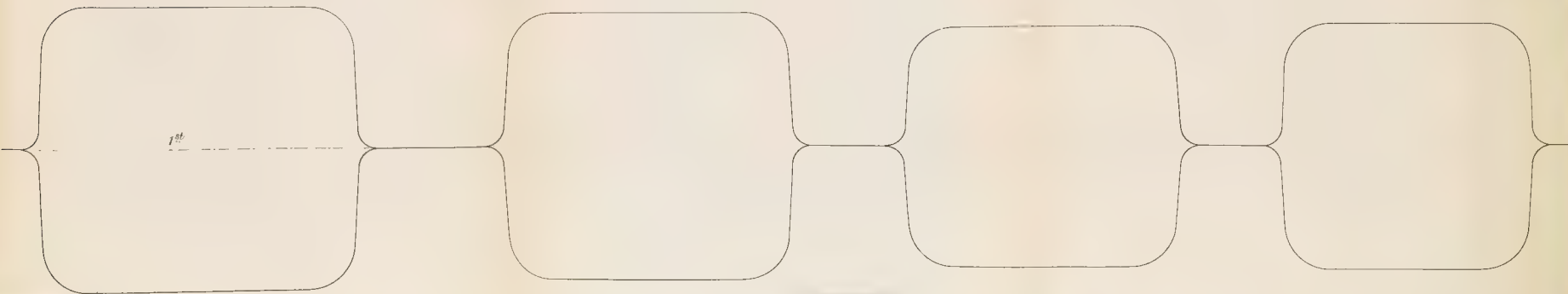


CONTINUATION OF GOTHIC ROUGHING FOR LARGE ROUNDS SEE PLATE LXXIII. GROOVES FULL SIZE.

PLATE LXXIV



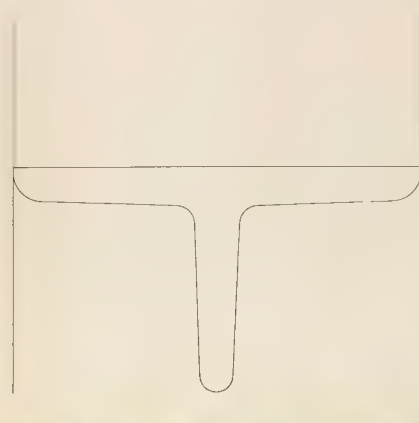
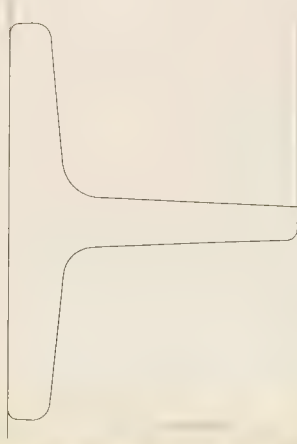
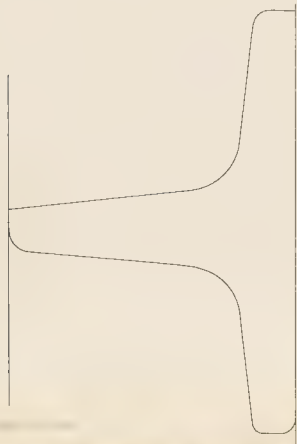
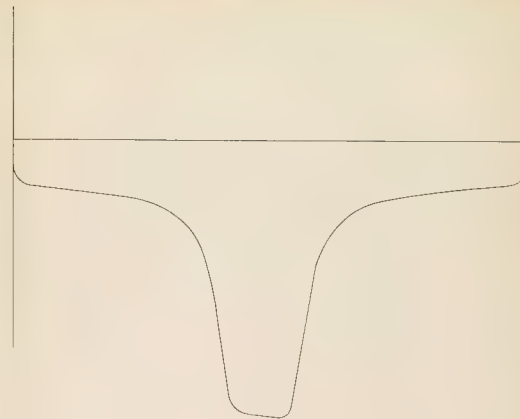
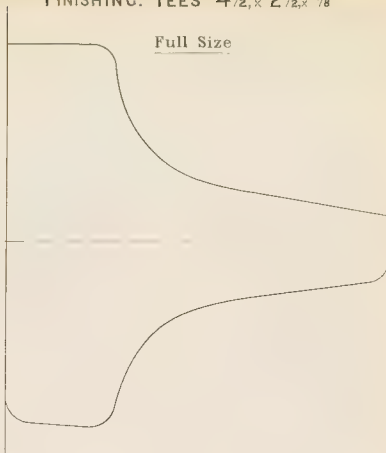
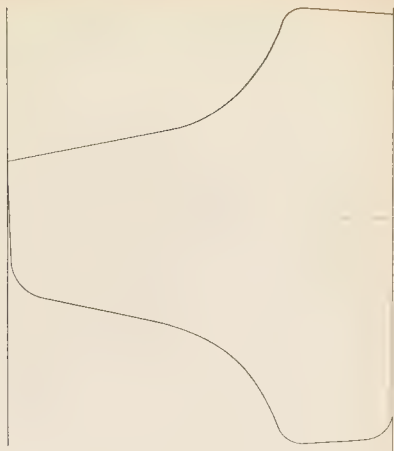
FLAT & EDGE LEADING GROOVES TO ROUGHING FOR LARGE ROUNDS SEE PLATE LXXIII. GROOVES HALF SIZE.



FINISHING. TEES $4\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$

Full Size

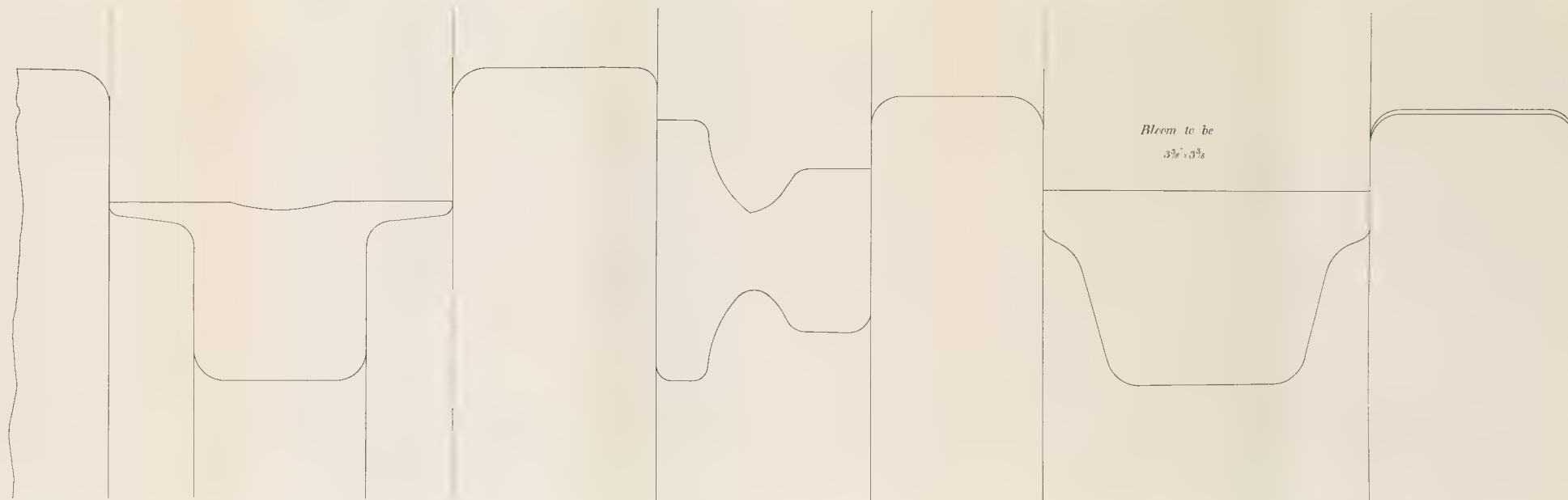
Plate LXXV.



18" MILL ROLLS.

FINISHING FOR STEEL FLANGE RAILS. GROOVES FULL SIZE.

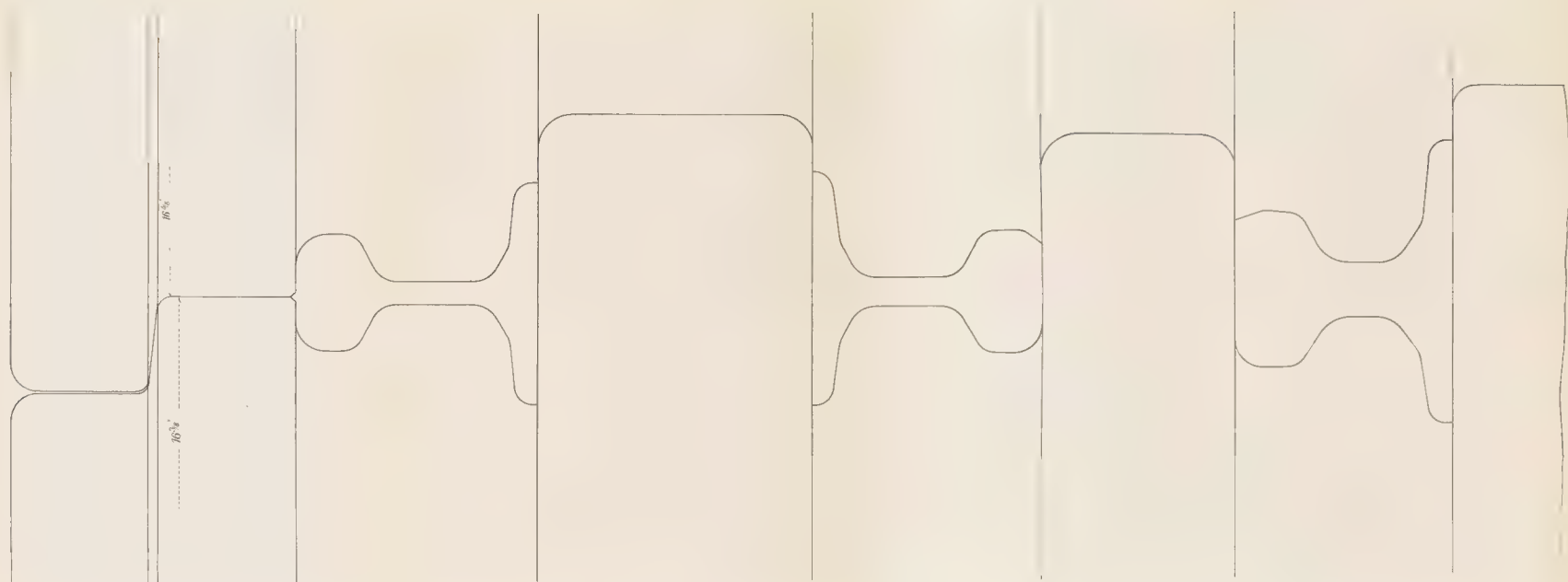
Note Completed on Plate LXXVII.

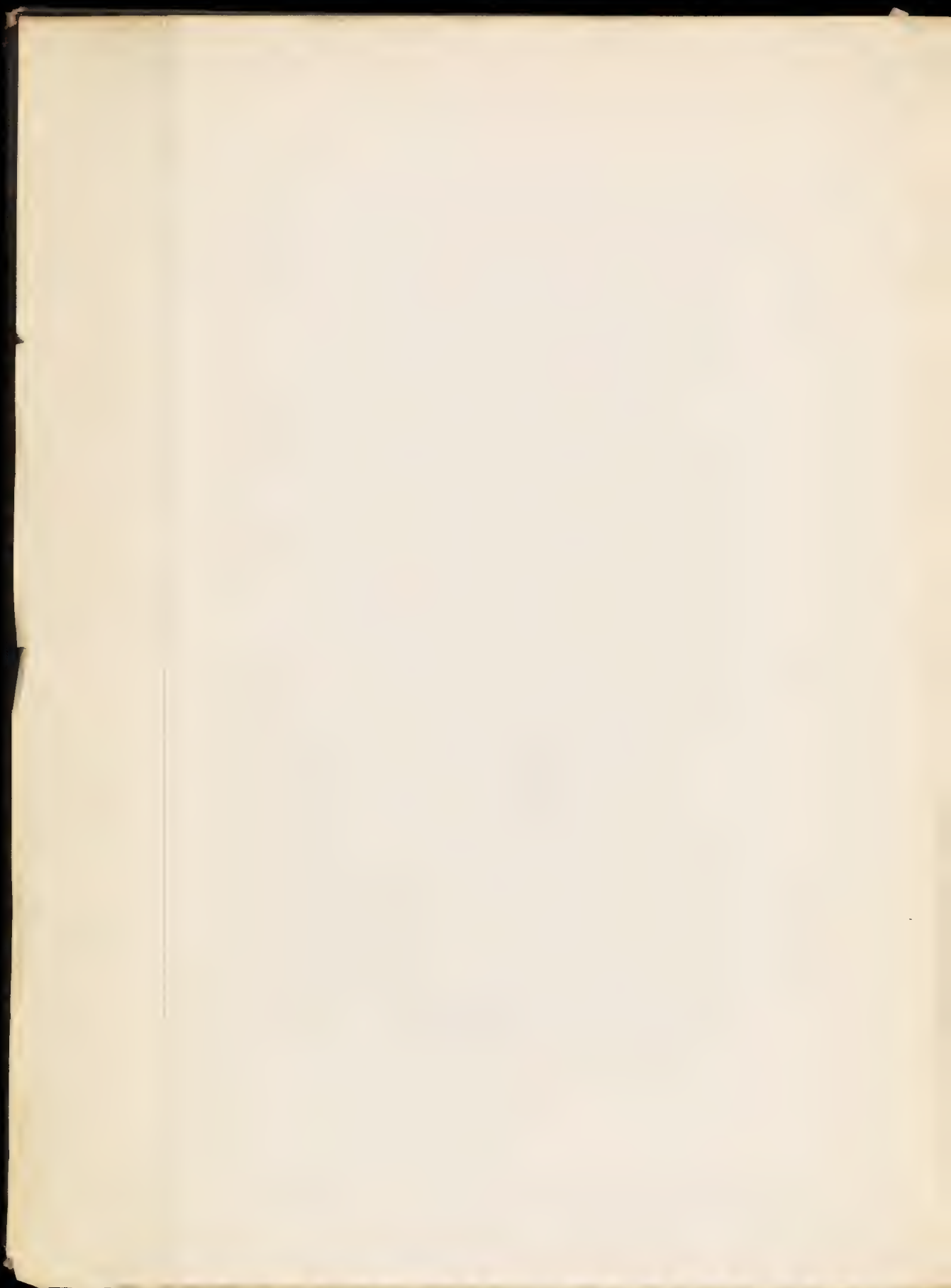


STEEL FLANGE RAILS. 18" MILL-FULL SIZE GROOVES.

Note: Continuation of Plate LXXI

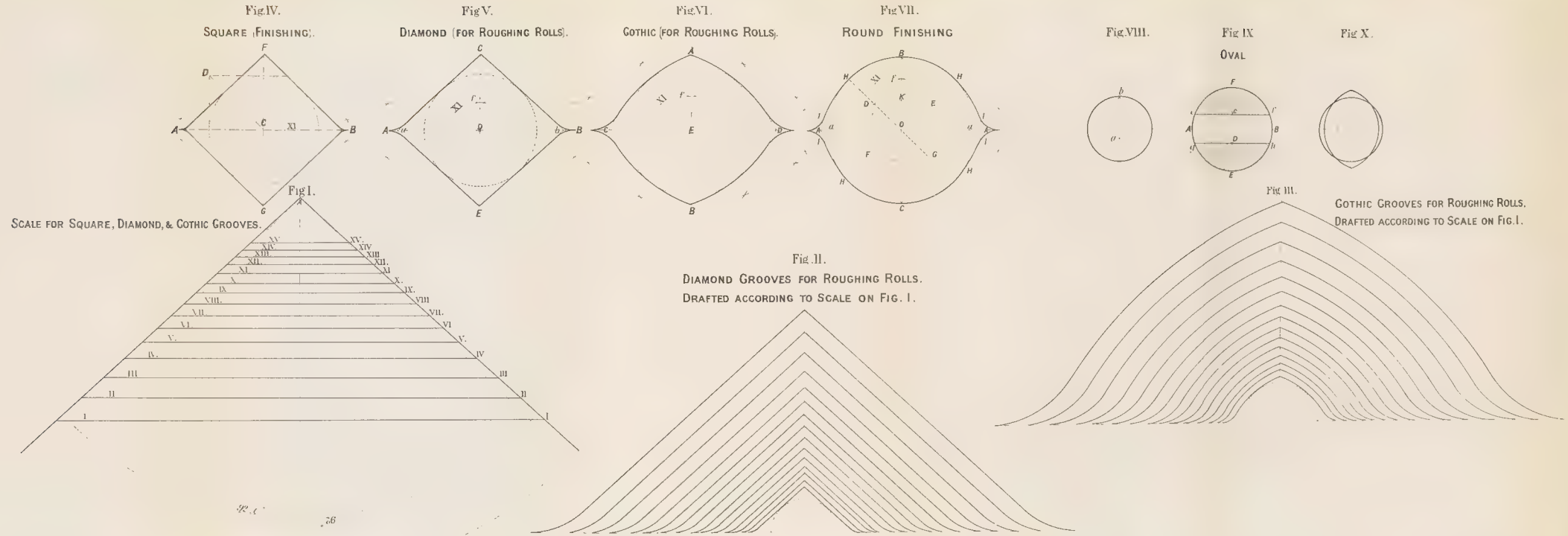
15th Per Mètre





METHOD OF DRAWING GROOVES FOR SQUARES, DIAMONDS, GOTHICS, ROUNDS, & OVALS.

PLATE LXXVII

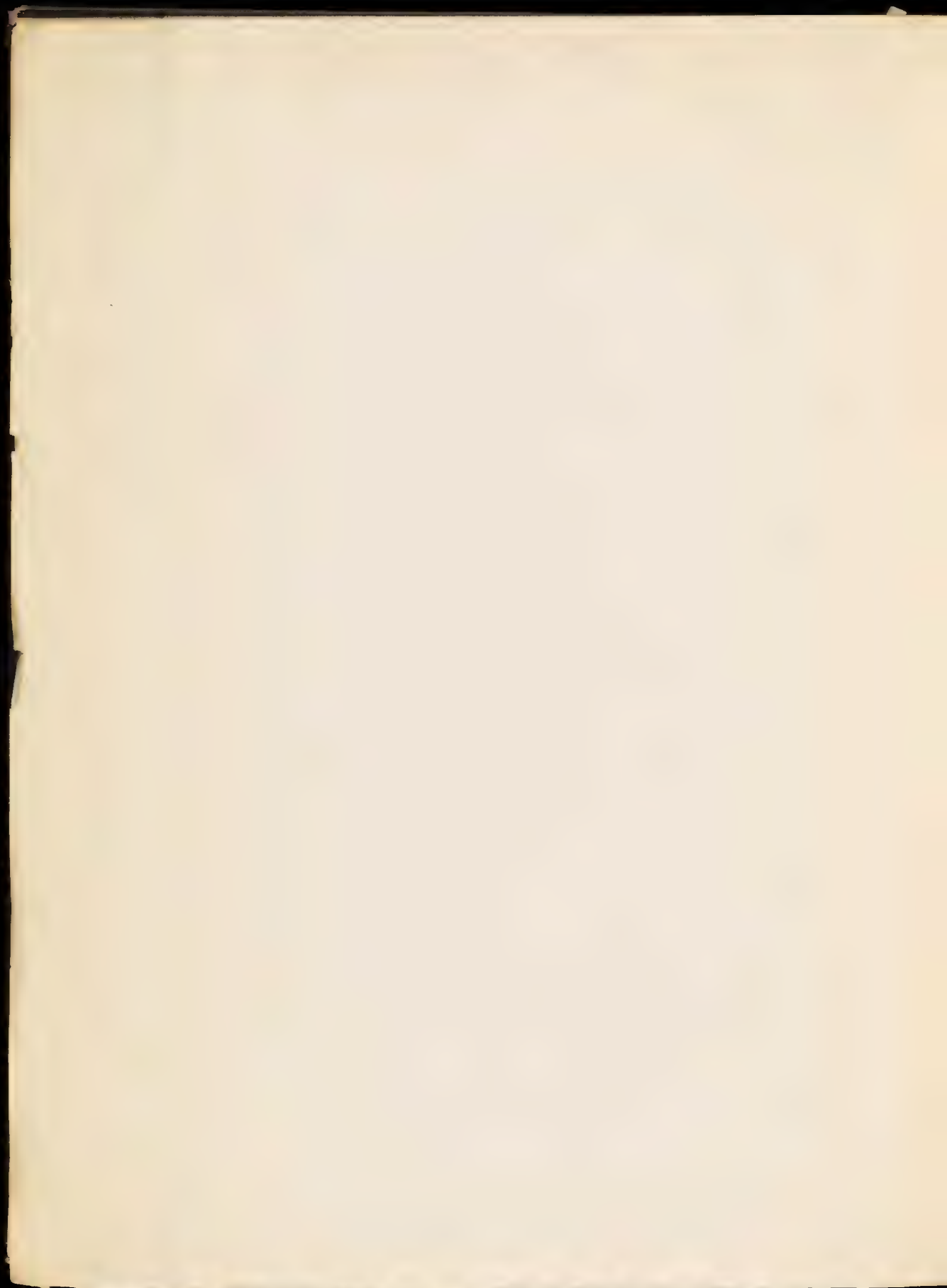


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26. 5. B. 5. 00

2. 6. 5. 00. London & New York



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